# Status and Conservation Management of Terrestrial Mollusks of Special Concern in Montana

Prepared for:
The U.S. Forest Service

By:
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Montana Natural Heritage Program
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## EXECUTIVE SUMMARY

This document presents information on the distribution and status of 15 terrestrial mollusk taxa (species and subspecies) of conservation concern in Montana that have been found on or near lands administered by the Northern Region (Region 1), U. S. Forest Service. Included in this group are ten snail taxa and five slug taxa. Each species or subspecies is on the current joint Montana Natural Heritage Program and Montana Fish, Wildlife and Parks Animal Species of Concern list (Carlson 2003), as either a Species of Concern (eight snail and three slug taxa) or On Review (two snail and one slug taxa); one slug species On Review (*Udosarx lyrata*) includes a subspecies (*U. l. russelli*) that is a Species of Concern.

Montana is the type locality (where the species or subspecies was first discovered and upon which the formal description is based) for ten of the mollusk taxa discussed in this report. A review of available literature and unpublished reports, museum records, personal discussions and correspondence, and field survey results provided only 66 locality records for all species and subspecies combined. No species has been reported in Montana at as many as 15 localities, and only two snails have been documented at as many as ten localities. Two snails remain known from single localities each (the type localities), and five other snails and slugs from two to four localities each. To date (2002), terrestrial mollusks of conservation concern have been found on or near seven National Forests in Montana: Beaverhead-Deerlodge, Bitterroot, Flathead, Gallatin, Kootenai, Lewis and Clark, and Lolo.

Of the 66 total localities, Heritage Program zoologists discovered nine since 1997, and two additional localities were first reported in 2001 by other biologists. These results, obtained largely with a minimum of survey effort, indicate that new populations for several of the species of conservation concern are possible, even likely. However, given the history of collecting in the state west of the Continental Divide, it is expected that most of the mollusk taxa on the Heritage list will remain there, although their global and state ranks may ultimately be downgraded.

In this report, species accounts for each taxon are provided that include details of taxonomy and species identification, life history and ecology notes, a distribution map, and comments on status, potential threats, and land ownership at documented (historical and recent) locations. Appendices include a summary of all location and museum collection information, guidelines for conducting surveys and inventories of terrestrial mollusks, and a key to the genera of terrestrial mollusks in Montana. It is hoped that this document will 1) bring to the attention of Forest Service biologists the existence of a group of small animals of conservation concern that inhabit or may inhabit lands under their stewardship, and 2) help Forest Service biologists design and conduct forest inventories for these species. The ultimate goal of this document is to assure the long-term conservation of these species by having their needs addressed in forest plans.

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**ACKNOWLEDGMENTS**

I am particularly grateful to Fred Samson (USDA Forest Service) for recognizing invertebrates as part of the native fauna inhabiting The Northern Region, and concluding there is a need to address the conservation issues invertebrates confront. John Carlson, Montana Natural Heritage Program (MTNHP) Lead Zoologist, was instrumental in seeing solidified the agreement between the U.S. Forest Service and MTNHP to develop this document.

Information gathered here was assembled from published literature, unpublished reports, field surveys, museum collections, and personal communications with agency, academic, and private-sector biologists. I am grateful to the mollusk collection managers of the California Academy of Sciences (CAS), the Academy of Natural Sciences of Philadelphia (ANSP), the Field Museum of Natural History of Chicago (FMNH), and the U.S. National Museum (USNM) for providing museum records. I also extend thanks to Lee Fairbanks, Terry Frest, Bill Hammer, Bill Leonard, Tom Burke, Heike Reise, and Bryce Maxell for providing specimen records, advice, or both. Bill Leonard was also generous in sharing his photographs of several slug species.

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Finally, I express my thanks to Dr. Royal Bruce Brunson (deceased), Emeritus Professor of the Department of Zoology, University of Montana and mid-twentieth century student of Montana's mollusk fauna, for sharing his knowledge and providing enthusiastic support of my novice attempts to rediscover what was known decades before. This report is dedicated to him.

## INTRODUCTION

**Background.** This document is intended to serve as a concise summary of current knowledge on the status, distribution, life history, and ecology of terrestrial mollusks (slugs and snails) determined by the Montana Natural Heritage Program to merit state Species of Concern or On Review designation (see Carlson 2003). The information gathered has been used to 1) identify real and potential threats to terrestrial mollusks of conservation concern that may occur on U.S. Forest Service, Northern Region lands in Montana, and 2) develop guidelines for field surveys and monitoring schemes on Forest Service units for terrestrial mollusks of conservation concern. The project is a joint venture of the U.S. Forest Service, Northern Region with the Montana Natural Heritage Program.

Species and subspecies in this document (Table 1) are included on the joint Montana Natural Heritage Program/Montana Department of Fish, Wildlife & Parks list of Animal Species of Concern (Carlson 2003). They were so listed based on information and recommendations in Frest and Johannes (1993, 1995) for species occurring in the Interior Columbia River Basin and the Black Hills of South Dakota and Wyoming (the Black Hills region includes two species of concern that also are present in Montana); several species included are covered in the Columbia River Basin invertebrate assessment report (Niwa et al. 2001), where listing is also recommended. Montana is the type locality (where the species or subspecies was first discovered and upon which the formal description is based) for 10 of these taxa (see Appendix B).

**Table 1**. Terrestrial snail and slug Species Of Concern or On Review in Montana (Carlson 2003). An asterisk (*) following a scientific name indicates the species was recommended for listing in the Columbia River Basin invertebrate assessment report (Niwa et al. 2001).

| Scientific Name | Common Name | Heritage Rank[a] | Heritage Category |
|---|---|---|---|
| **Snails** | | | |
| *Discus brunsoni** | Mission Range Disc | G1 S1 | Concern |
| *Discus shimeki* | Striate Disc | G4 S1 | Concern |
| *Oreohelix alpina** | Alpine Mountainshell | G1 S1 | Concern |
| *Oreohelix amariradix** | Bitterroot Mountainshell | G1G2 S1S2 | Concern |
| *Oreohelix carinifera** | Keeled Mountainshell | G1 S1 | Concern |
| *Oreohelix elrodi** | Carinate Mountainshell | G1 S1 | Concern |
| *Oreohelix strigosa berryi* | Berry's Mountainshell | G5T2 S1S2 | Concern |
| *Oreohelix yavapai mariae* | Gallatin Mountainshell | G4?T1 S1 | Concern |
| *Polygyrella polygyrella* | Humped Coin | GU SU | Review |
| *Radiodiscus abietum* | Fir Pinwheel | GU SU | Review |
| **Slugs** | | | |
| *Hemphillia danielsi** | Marbled Jumping Slug | G1G3 S1S3 | Concern |
| *Magnipelta mycophaga** | Spotted Slug | G2G3 S1S3 | Concern |
| *Udosarx lyrata**[b] | Lyre Mantleslug | GU SU | Review/Concern |
| *Zacoleus idahoensis* | Sheathed Slug | G3G4 S2S3 | Concern |

[a] G = Global Rank, S = State Rank. See Appendix A for definitions of abbreviations and ranks.
[b] A described subspecies, *Udosarx lyrata russelli* (Russell Mantleslug), is ranked G?T1 S1 and placed on the Concern list. It is discussed under the Lyre Mantleslug because separate treatment is not justified here. Both forms of *Udosarx lyrata* were recommended for listing in the Columbia River Basin invertebrate assessment report (Nixa et al. 2001).

Although the two reports by Frest and Johannes form the basis for focus of mollusk conservation in Montana, it is worth noting that large portions of Montana still await evaluation of their molluscan fauna. The Interior Columbia River Basin report (Frest and Johannes 1995) covers just that part of Montana west of the Continental Divide and two peripheral species of concern; the Black Hills report (Frest and Johannes 1993) does not cover Montana at all, but discusses two species of concern present also in Montana.

**A Brief History of Land Mollusk Faunal Inventories in Montana.** Only a few publications provide accounts of the extant land mollusk faunas in Montana. Elrod (1902) presented the first (and apparently only) list of known species for the state, while recognizing that the list was necessarily incomplete due to inadequate collecting over much of the area, a problem persisting to this day. Elrod's (1902) report included brief mention of three species of conservation concern (*Pyramidula* [=*Oreohelix*] *elrodi*, *Pyramidula* [=*Oreohelix*] *alpina*, and *Polygyrella polygyrella*) in western Montana, and included the records of Squyer (1984) from the Wibaux area (known as Mingusville), which represented essentially the only information from the eastern parts of Montana at that time. Shortly thereafter, Berry (1916) published a summary of his collecting efforts in Meagher and Fergus counties, incorporating his earlier and briefer report (Berry 1913) and including an account of *Oreohelic strigosa berryi* in the Big Snowy Mountains. At this same time, Vanatta (1914) published a list of species collected by L. E. Daniels in the Bitterroot Mountains, which included the first records of the endemic slug *Hemphillia danielsi*.

Little else appeared in print for some time, until Russell and Brunson (1967) compiled what was known about the mollusk fauna of Glacier National Park, which updated an earlier report by Berry (1919) and included many new observations by the authors. The Russell and Brunson (1967) list is probably the most complete for any area of significant size in Montana. Interestingly, none of the land mollusks of state conservation concern have been documented in Glacier National Park. Unfortunately, Brunson (who qualified as the most knowledgeable malacologist residing in Montana for the second half of the 20$^{th}$ Century) never wrote a revision of Elrod's (1902) out-dated state list, even though several additional species were known to occur in Montana by the time Brunson retired from active collecting in the early 1980's.

The records of new terrestrial mollusk species and locations for Montana, including several of conservation concern, remain scattered in publications of more narrow scope, many of them now decades old (e.g., Bartsch 1916, Pilsbry and Brunson 1954, Brunson and Osher 1957, Brunson and Russell 1967, Fairbanks 1984), or deposited as vouchers in museum collections and otherwise unpublished. Fortunately, most or all of the species of greatest conservation interest in Montana are discussed in Frest and Johannes (1993, 1995) as part of mollusk assessments of the Black Hills and the Interior Columbia River Basin, respectively. Most recently (beginning in 1997), additional brief surveys for a few species have been made by Montana Natural Heritage Program zoologists, who also continue to solicit and accumulate opportunistic observations of mollusks for the Heritage databases, with focus on species of conservation concern as identified in the documents of Frest and Johannes (1993, 1995).

**Distribution and Status of Species of Conservation Concern.** A review of available literature and unpublished reports, museum records, personal discussions and field survey results provided only 66 locality records (see Appendix B) for the set of 15 terrestrial mollusk taxa of conservation concern listed in Table 1 (note that a subspecies of slug, *Udosarx lyrata russelli*, is discussed in the account of the species). Three snails (*Discus shimeki*, *Oreohelix strigosa berryi*, *Oreohelix yavapai mariae*) are known from sites east of the Continental Divide; the remaining taxa, including all of the listed slugs, are known only from sites west of the Continental Divide. No taxon has been reported in Montana at as many as 15 total localities, and only two (*Oreohelix strigosa berryi* and *Radiodiscus abietum*) have been documented at as many as ten. Two taxa (*Discus brunsoni* and *Oreohelix yavapai mariae*) remain known from single localities each, five others (*Oreohelix alpina*, *Oreohelix amariradix*, *Oreohelix carinifera*, *Oreohelix elrodi*, and *Udosarx lyrata*) from two to four localities each.

All but one terrestrial mollusk species, the Mission Range Disc (*Discus brunsoni*), on the joint Montana Natural Heritage Program-Montana Department of Fish, Wildlife and Parks Animal Species of Concern list (Carlson 2003) have been documented on or near at least one National Forest unit in the Northern Region of Montana (Table 2). Other National Forests not listed in Table 2 are likely to support one or more terrestrial mollusk species of conservation concern, given the wide distribution of some of these, such as the Striate Disc (*Discus shimeki*) and Berry's Mountainshell (*Oreohelix strigosa berryi*). Many of the listed National Forests are likely to support additional taxa of conservation concern not yet documented on their lands.

**Table 2.** Terrestrial mollusk Species of Concern or On Review (Carlson 2003) that have been documented on National Forest lands of the Northern Region (Region 1). Species in brackets ([ ]) indicate a species that has been documented < 2 km from a particular forest boundary.

| Forest | Mollusk Species |
|---|---|
| Beaverhead-Deerlodge | *Zacoleus idahoensis* |
| Bitterroot | *Hemphillia danielsi, Radiodiscus abietum, Udosarx lyrata* |
| Flathead | *Magnipelta mycophaga, Oreohelix alpina, Oreohelix elrodi* |
| Gallatin | *Discus shimeki, Oreohelix strigosa berryi, Oreohelix yavapai mariae* |
| Kootenai (including Kaniksu in Montana) | *Discus shimeki, Magnipelta mycophaga, Radiodiscus abietum, Zacoleus idahoensis* |
| Lewis and Clark | *Oreohelix strigosa berryi* |
| Lolo | [*Hemphillia danielsi*]*, Magnipelta mycophaga, Oreohelix amariradix, Oreohelix carinifera*, *Polygyrella polygyrella, Radiodiscus abietum, Zacoleus idahoensis* |

These scant results lead to two conclusions: 1) most species/subspecies of special concern are very rare, existing in small, often isolated populations, and 2) survey coverage in Montana has been woefully inadequate to provide a reasonable assessment of the distribution and status of

most or all taxa. Field surveys and opportunistic observations indicate both conclusions probably are reasonable. With very limited resources, Heritage Program zoologists have documented four priority species at nine new localities (of the 66 total localities for all priority species) since 1997, and determined that populations of three species remain extant at five additional localities not sampled in the previous 30 years (see Appendix B). A new locality (one of three) for the Carinate Mountainshell (*Oreohelix elrodi*) was discovered in 1999; two of five total Montana localities so far documented for the Marbled Jumping Slug (*Hemphillia danielsi*) were reported first in 2001 by other biologists. Thus, very brief field surveys and opportunistic encounters in recent years have significantly increased the number of localities where terrestrial mollusks of conservation concern have been found. Nonetheless, some species (especially several species of *Oreohelix* and *Discus brunsoni*) have been the focus of numerous searches over the last several decades (Frest and Johannes 1995, R. B. Brunson pers. comm.) with few or no new populations discovered.

Uncertainty regarding which species are present on National Forests is due to a general lack of the most cursory of inventories to identify the terrestrial mollusk faunas occupying public lands throughout Montana. Thus, to gauge the significance of federal lands for maintaining snails and slugs considered rare and of conservation concern, a priority should be placed on conducting field surveys of appropriate habitats where these species might occur on National Forests of the Northern Region (see Appendix C for guidelines). The evidence from recent field work indicates additional surveys will result in the discovery of several additional populations for some species, most likely the slugs, but most or all mollusk species currently on the Species of Concern lists (Carlson 2003) probably will continue to be identified as relatively rare and of limited distribution in Montana.

The discovery of new locations will lead to a reassessment of the status of the listed species in Montana as well as on particular National Forests. However, species new to the known mollusk fauna of Montana are still possible. As an example, a slug species "discovered" (in a museum collection) during the development of this document, the Smokey Taildropper (*Prophysaon humile*) (see Frest and Johannes 1995), not yet on the joint Montana Natural Heritage Program/Fish, Wildlife & Parks list of "Animal Species of Concern" (Carlson 2003), is now known to be present in Montana (see Appendix C) and will be added to the list in the near future because it is of conservation concern elsewhere in the Interior Columbia River Basin (Frest and Johannes 1995, Niwa et al. 2001). Thus, with additional survey documentation, we can expect that several species will be added to the individual National Forest lists, including some that may not yet be known to occur in Montana. But with continued survey effort we can also anticipate that some species will be dropped from the list of species of conservation concern in Montana because they are known to be more secure than their current ranks indicate.

**Summary of Occupied Habitats.** Generally speaking, the 15 terrestrial mollusk species of conservation interest in Montana (Table 1) fall into two habitat groupings: 1) species often associated with talus or rocky outcrops (Talus Group), and 2) species often associated with moist valley and canyon (ravine) mixed-conifer forests (Moist Forest Group). The two groupings may overlap in some cases; some of the moist mix-conifer forest species are often found in rocky sites, and the talus-inhabiting species may occupy talus imbedded in a forested landscape. But the microhabitats where these two groups occur are usually easy to differentiate.

All of the *Oreohelix* species listed in Table 1, as well as *Discus brunsoni*, associate with talus or rocky ground, although the occupied sites may range from low-elevation canyons and valley bottoms to high-elevation slopes well above treeline. Sites occupied by this group are typically in terrain that is more open and mesic than where the second group associates. Sites occupied by the second group (the four slugs, *Discus shimeki*, *Polygyrella polygyrella*, *Radiodiscus abietum*) tend to be near permanent water, such as riparian corridors, and in dense conifer forests where there is more precipitation, litter and decaying wood. This group of species also frequents areas with a deciduous wood component of species such as aspen, cottonwood, alder and birch.

**Potential Threats**. No studies exist that document the response of any of the 15 terrestrial mollusk species of conservation concern to disturbance. Threats to populations of these species is largely guess work, and based on the type and extent of habitat alteration and disturbance that has occurred in Montana in the last century.

Any kind of habitat alteration that reduces the humidity of the microhabitats where these species occur is a potential threat to both groups, but probably greatest for the Moist Forest Group. Canopy removal through logging and fire are probably the most significant disturbances for the forest-inhabiting species; historical forest clearing has likely resulted in significant reductions and fragmentation of their former ranges. Logging and fire are also potentially significant factors of disturbance for talus-inhabiting species, but talus occupied by these species may be deep enough to provide necessary humidity and temperature regimes that will protect them from logging and fire, at least in some cases and in the short term. However, construction of roads to support logging operations could threaten even some of these seemingly protected talus sites.

Grazing has the potential to negatively impact both groups, but some of the species inhabiting talus (especially *Discus brunsoni*, *Oreohelix alpina*, and *Oreohelix elrodi*) are probably largely buffered from grazing impacts due to the specific types of rocky terrain they occupy. For other species in more expose sites, trampling and grazing could devastate the habitat occupied by the snails and slugs, removing plant cover and potential food, and destabilizing occupied slopes. Rural home development and highway and road maintenance also have the potential to contribute to habitat loss for several species in both groups largely restricted to low-elevation valleys and slopes in apparently very localized populations (*Oreohelix amariradix* and *Oreohelix carinifera* are examples).

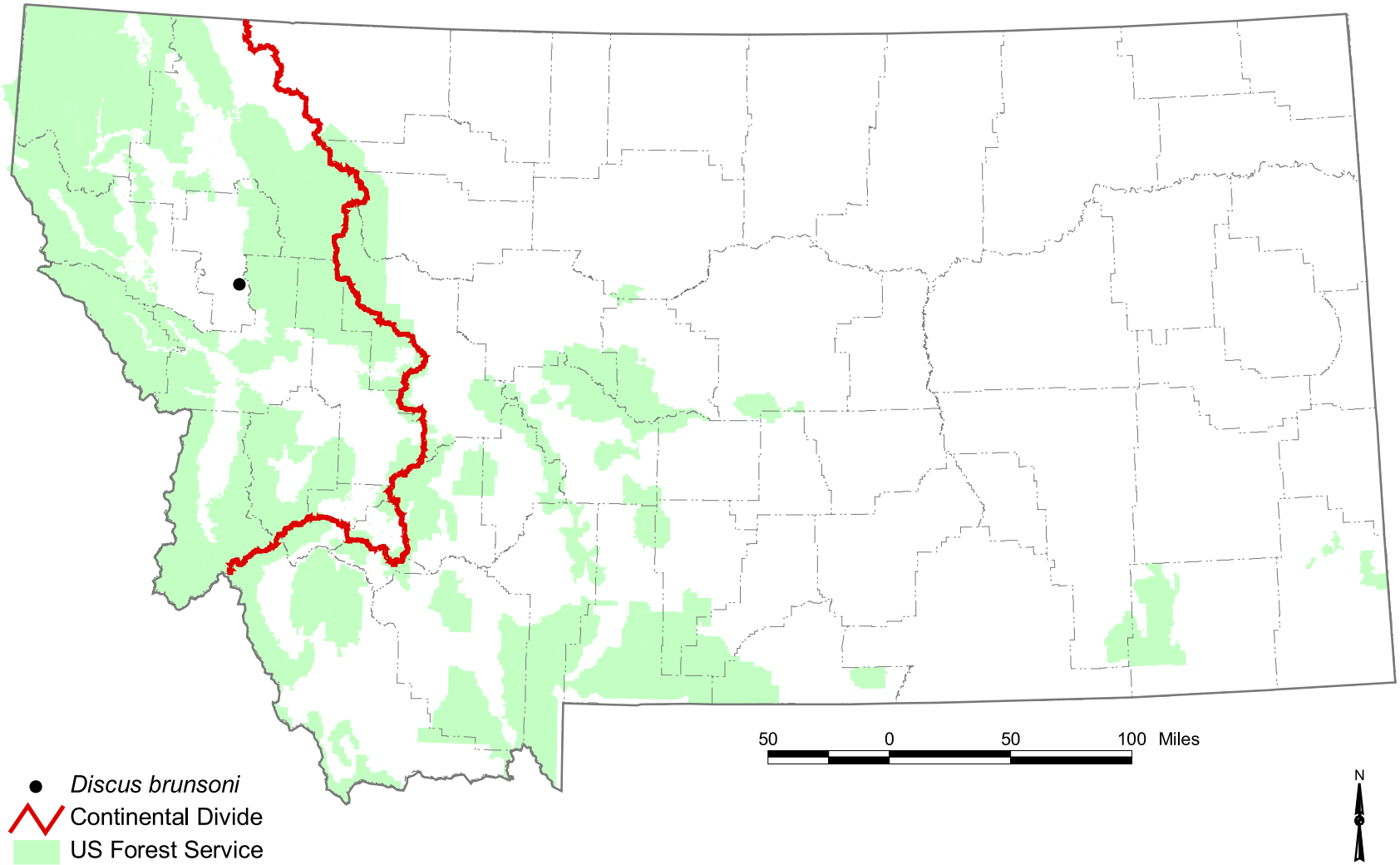
Use of chemicals for controlling noxious weeds could present land managers with situations where protection of rare animal species is balanced against the need to control or eradicate exotic pest species, and special effort may be required to assure the protection of the mollusks during these operations. Several of the mollusk species of conservation concern probably occupy areas where control of noxious weeds is desirable, especially along heavily used roads and trails. During the writing of this report it was discovered through conversation with Forest Service personnel that a weed control program will soon occur at the only site known for the Gallatin Mountainsnail (*Oreohelix yavapai mariae*). A survey of the site should be conducted before spraying to identify the area occupied by the snails, so that disturbance to this rare endemic snail can be avoided. Similar situations such as the above will probably occur in the future as weed control receives more emphasis. This further underscores the need for new surveys to identify

sites currently occupied by the terrestrial mollusks of conservation concern discussed in this report.

**Summary of this report.** The species accounts that follow include information on taxonomy and species/subspecies identification (including photographs when available), life history notes on reproductive biology, ecology and habitat associations, information of the range-wide distribution and distribution within Montana (including distribution maps), current abundance, potential or real threats, and land ownership at known localities. In some sections, particularly threats and distributions, what is written is too often speculation. This is unavoidable because so little is known of these topics about most species of conservation concern.

A bibliography pertaining to the species of conservation concern, which includes most or all of the published and gray literature mentioning the species that are the focus of this report, is included at the end of the individual species accounts. A table summarizing available geo-spatial data for each occurrence, along with collection/observation dates and museum accession numbers, as well as available habitat information briefly noted, is provided in Appendix B. Guidelines for designing and conducting field surveys are provided in Appendix C. A key to the genera of terrestrial Montana mollusks is provided in Appendix D as an aid to field workers encountering snails and slugs and attempting an initial determination of what they have found. It is hoped that the production of this report will impress upon agency and private sector biologists the magnitude of our ignorance, and spur them to take measures to reduce it.

**Figure 1. Distribution of *Discus brunsoni* in Montana.**



## SPECIES ACCOUNTS

## SNAILS

**SPECIES:** *Discus brunsoni* (Mission Range Disc)

**Heritage Rank**: G1, S1

**Natural History**

### A. Taxonomy

Family: Discidae
*Discus brunsoni* Berry, 1955

Berry (1955) described this distinctive taxon as a full species. There remain questions regarding its true taxonomic affinities, but complete knowledge will not affect the validity as a full species (see Frest and Johannes 1995).

### B. Species Description

Morphology: The following description is taken from Berry (1955). "Shell large for the genus, thin, depressed-conic, with low spire, its slopes weakly convex. Whorls about five and a half, decidedly compressed, moderately rounded both above and below the strongly but not acutely carinate periphery, . . . ; base flattened, the widely open vorticiform umbilicus contained about three times in the major diameter of the shell; . . . Aperture transversely ovate, compressed, . . . Color near olive-brown, . . . the basal surface and that of young shells tending to be a little brighter; no inherent variegation of color pattern evident." Maximum diameter of holotype 10.5 mm, minimum diameter 9.1 mm; height of shell 4.2 mm, diameter of umbilicus 3.5 mm. Maximum diameters of eight live individuals measured by Hendricks (1998) ranged from 6.7 mm to 10.5 mm (mean = 9.5 ± 1.4 mm).

Reproductive biology: Hermaphroditic, so far as known. Internal anatomy is not yet described (Berry 1955, Frest and Johannes 1995), and there are no descriptions of the reproductive behavior and its seasonal occurrence. Lifespan is unknown. Age/size at maturity is unknown.

Ecology: Occupies open, south facing and rather dry talus slopes with very low canopy cover. Vegetation at the margins of the talus slopes includes Douglas-fir (*Pseudotsuga menziesii*), ponderosa pine (*Pinus ponderosa*), pockets of water birch (*Betula occidentalis*), quaking aspen (*Populus tremuloides*), and mock orange (*Philadelphus lewisii*). Rock composition at the type locality was described as limestone (Berry 1955, Frest and Johannes 1995), but more recent examination (Hendricks 1998) revealed the occupied talus to be a mix of diorite and argillite with no limestone present. Apparently this species retreats deep into the talus when surface conditions are unfavorable. Brunson (1956) suggested that *D. brunsoni* may be

crepuscular or nocturnal near the surface, because many collections were made shortly before dusk, or at least in subdued light, following intensive mid-day searches. Hendricks (1998), however, located live animals at the surface during mid-day when ambient surface conditions were overcast, wet and cool. *Oreohelix elrodi* is also present in the occupied talus. Foods are unknown, but it may feed most often on plant material on rock surfaces (lichens, etc.) rather than patches of accumulated leaf and conifer needle litter (Brunson 1956, Hendricks 1998).

### C. Range and Known Sites

*Discus brunsoni* is known only from the Mission Mountains in Lake County, northwestern Montana (Fig. 1, Appendix B). The type locality is the south-facing slope above McDonald Lake in the Mission Mountains Tribal Wilderness of the Confederated Salish and Kootenai Tribes, at about 1120 m (3700 ft) elevation. Several talus slopes are present above the north shore of the lake; Brunson (1956) indicates more than one slope is occupied, but Hendricks (1998) found *D. brunsoni* only in the talus slope where diorite was abundant.

To date, the type locality is the only location where *D. brunsoni* has been found. Over 70 specimens of this species have been uncovered in seven different years since the first shell was found in August 1948; the most recent known observation was in July 1997 (Hendricks 1998).

### D. Species Abundance

*Discus brunsoni* is a local endemic, perhaps present only in the Mission Mountains. Because the species occupies large and deep talus slopes it is difficult to make estimates of population size. During favorable surface conditions, Hendricks (1998) found it to be much less abundant near the surface than sympatric *Oreohelix elrodi*, another regional endemic of conservation concern.

## Current Status

### A. Why Species is of Conservation Concern

The Mission Range Disc (*Discus brunsoni*) is a Species of Concern in Montana because it is a local endemic so far documented at a single site, despite several decades of widespread collecting in the region by Dr. R. B. Brunson and students (Frest and Johannes 1995, Brunson personal communication). Population size and trends are unknown. Recommended for Federal listing by Frest and Johannes (1995).

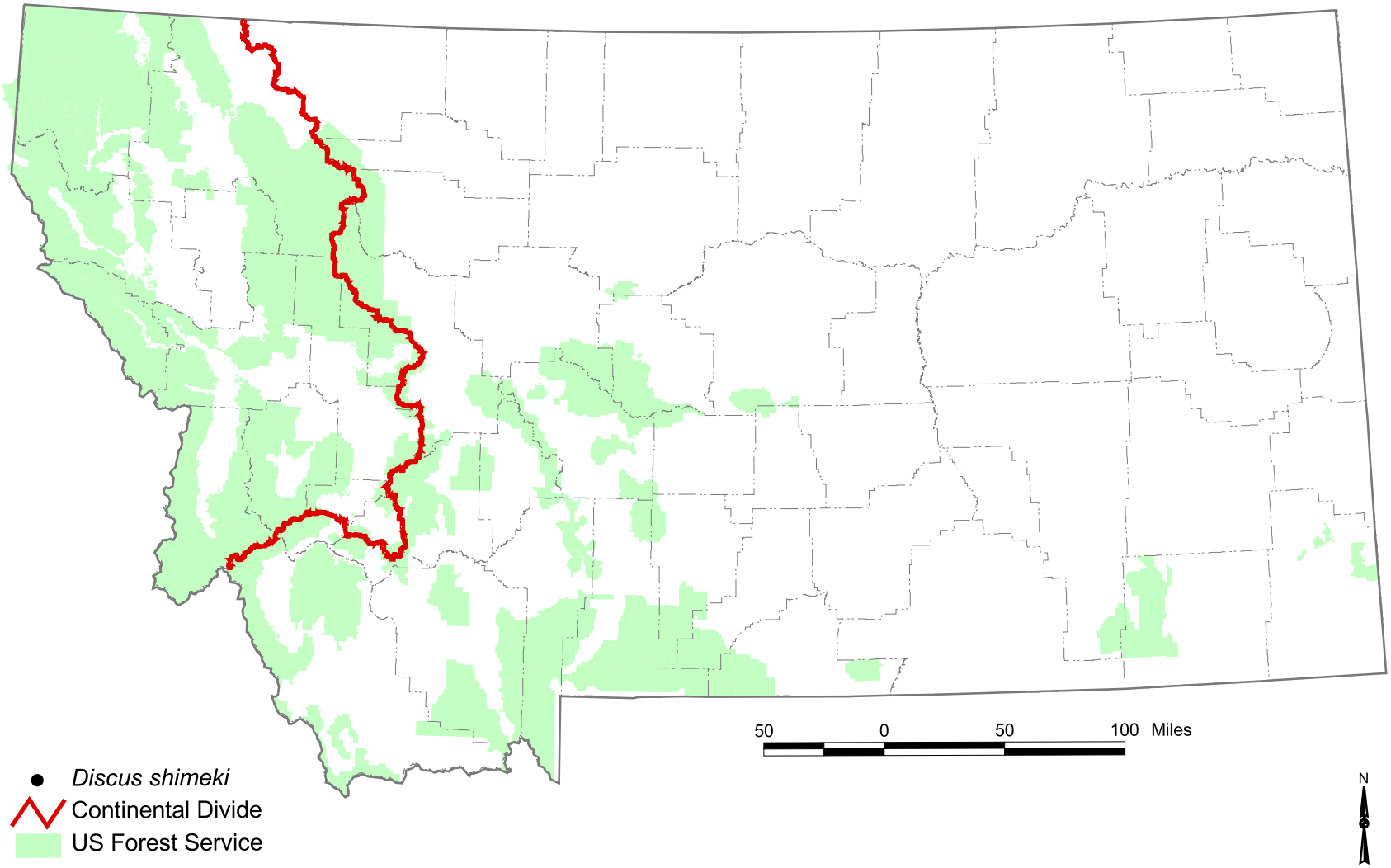
### B. Threats

Although the occupied habitat is not particularly threatened by development or agriculture (logging and grazing), habitat requirements and food habits are poorly understood. Fire suppression efforts (especially use of fire retardants) and talus destabilization (trail maintenance, modification) could have negative impacts. Also, given the trail-side location, weed control efforts could negatively impact the population.

## C. Distribution Relative to Land Allocations

The only known occupied site is in the Confederated Salish and Kootenai Tribes Mission Mountains Tribal Wilderness. A major hiking and packing trail bisects the site. Additional populations associated with diorite and argillite talus may be present elsewhere in the Mission Mountains on tribal and national forest lands. There are quartz diorite outcrops that should be surveyed in the North Fork and South Fork of Elk Creek drainages in the Flathead National Forest, and near the Crow Creek Lakes in the Mission Mountains Tribal Wilderness.

**Figure 2. Distribution of *Discus shimeki* in Montana.**



**SPECIES:** *Discus shimeki* (Striate Disc)

**Heritage Rank**: G4, S1

**Natural History**

**A. Taxonomy**

Family: Discidae
*Discus shimeki* (Pilsbry, 1890)

Originally described from fossil material in Peoria Loess in Iowa. The extant western subspecies, *D. s. cockerelli*, is considered by some authorities to be indistinguishable from the nominate form (Frest and Johannes 1993).

**B. Species Description**

Morphology: The following description is from Pilsbry (1948). "The whorls are much more robust than *D. cronkhitei*. It has a low conic spire, rounded periphery and rather narrowly umbilicate base, the umbilicus contained about 3.7 to 4 times in the diameter. The first whorl projects somewhat, the first 1½ whorls smooth; following whorls regularly and rather strongly rib-striate, . . . [the ribs] become somewhat lower and irregular on the last whorl, where they disappear in the peripheral region, the base being marked only with weak wrinkles of growth." This snail differs from the sympatric *Discus cronkhitei* (= *whitneyi*) by its smoother base and weaker ribs on the last whorl. The shell is thin, and brownish in color. Height is about 3.7 mm, maximum diameter about 6-7 mm; 4.5 whorls.

Reproductive biology: Hermaphroditic. Copulation observed in March-June. Egg laying occurs from April-August in the Black Hills; clutch size is relatively small (3-6). Apparently most members of this species have a one-year life cycle (Frest and Johannes 1993). Age/size at reproductive maturity has not been described.

Ecology: This species tends to associate with quaking aspen (*Populus tremuloides*) at Montana sites where habitat was documented (Hendricks unpublished data). Elsewhere in the Rocky Mountains it is also associated with spruce (*Picea*) and fir (*Abies*) intermixed with aspen or other broadleaf trees and shrubs (Beetle 1957, 1997, Karlin 1961, Frest and Johannes 1993). Soils often are derived from weathering limestone. *D. shimeki* is active most often in litter in lowland forest, but sometimes is seen on downed wood and rock surfaces. Slopes are often north-facing and shaded. This species appears to subsist largely on decaying deciduous leaves.

**C. Range and Known Sites**

*Discus shimeki* is widely distributed in the Rocky Mountains of Arizona, New Mexico, Utah, Colorado, and Wyoming, with populations also extant in the Black Hills (Frest and Johannes 1993). It is also found north of Montana in the Canadian Rockies (Platt 1980). Pilsbry (1948)

lists only one Montana location for this species, along the Boulder River in Sweetgrass County (also referenced in Frest and Johannes 1993). The species has been documented in Montana (Fig. 2, Appendix B) in five counties total (Gallatin, Hill, Lincoln, Park, Sweetgrass), at elevations ranging from 640 m (2100 ft) to 1940 m (6360 ft). The most recent records are from along Beaver Creek in the Bears Paw Mountains, Hill County (1997) and west of Nurses Lakes (Gallatin National Forest) in the Absaroka Mountains, Park County (2001).

### D. Species Abundance

Population sizes are not reported. The species can be abundant in colonies, but colony sites are relatively small in extent (Frest and Johannes 1993). At some sites where the species has been documented in Montana, *D. shimeki* is less abundant than *D. cronkhitei* (=*whitneyi*) (pers. obs.).

## Current Status

### A. Why Species is of Conservation Concern

The Striate Disc (*Discus shimeki*) is a Species of Concern in Montana because of the limited number of sites where it has been documented in the state, despite several decades of widespread collecting in the region by Dr. R. B. Brunson and students (Frest and Johannes 1993, 1995). Recommended for Federal listing by Frest and Johannes (1993).

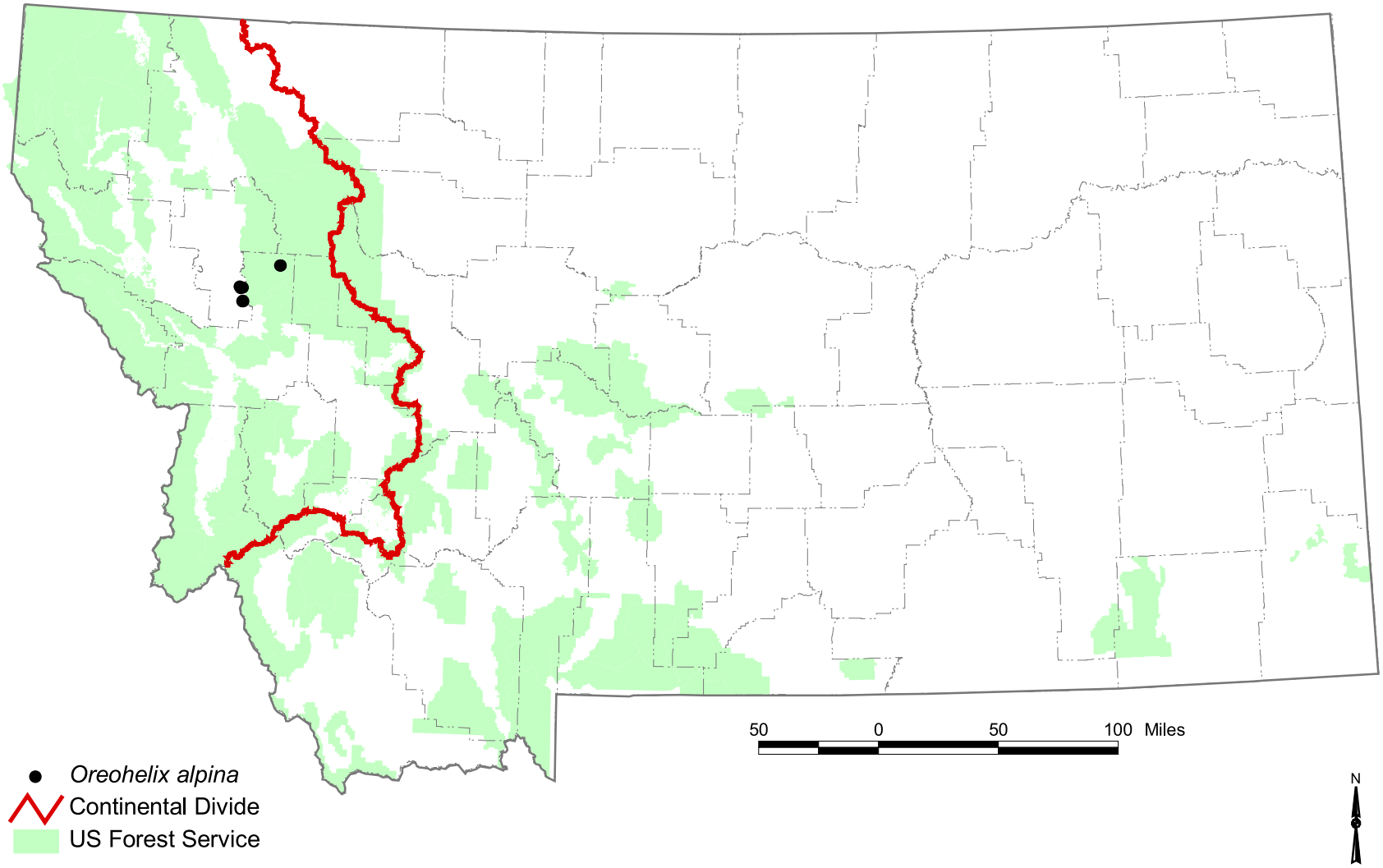
### B. Threats

Major threats to known sites include degradation due to timber harvest and livestock grazing, with the latter likely the main threat. Fire is also a concern; stand replacement fires could permanently eliminate populations in isolated colonies (see Beetle 1997). Response of snails to fire retardants has not been studied.

### C. Distribution Relative to Land Allocations

Known sites in Montana include Forest Service and Tribal lands at widely separated locations. Addition sites are possible on these as well as private lands throughout the montane regions of Montana, including some of the island mountain ranges in the prairie regions east of the main Rocky Mountain chain. None of the sites has special protection.

**Figure 3. Distribution of *Oreohelix alpina* in Montana.**



**SPECIES:** *Oreohelix alpina* (Alpine Mountainsnail)

**Heritage Rank**: G1, S1

**Natural History**

**A. Taxonomy**

Family: Oreohelicidae
*Oreohelix alpina* (Elrod, 1901)

Originally named *Pyramidula strigosa alpina* by Elrod (1901a, 1903b). Pilsbry (1939) expressed some doubt about the validity of this taxon, but later examination of material by Frest and Johannes (1995) and Fairbanks (2002) indicate treatment as a full species is appropriate. Pilsbry (1933) placed *Oreohelix alpina* with the *O. strigosa* group, as did Elrod (1901a, 1902, 1903b), but later (Pilsbry 1939) moved it to the *O. subrudis* group. Recent study of the internal anatomy (Fairbanks 2002) indicates affinity with the *O. strigosa* group. Pilsbry (1939) placed all *Oreohelix* in the Xanthonycidae.

**B. Species Description**

Morphology: Descriptions of shells from the Mission Mountains are provided in Elrod (1901, 1902, 1903b), Pilsbry (1939), Hendricks (1998), and Fairbanks (2002); reproductive anatomy is described in Fairbanks (2002). Description from Pilsbry (1939) follows: "shell small; brownish-gray, tending toward light horn color, in dead shells turning to pearly white; luster somewhat silky; shell flat, little elevated; . . . aperture nearly circular, . . . somewhat higher than wide; markings as in *strigosa*, the upper band continuing in the spire, gradually disappearing; umbilicus medium, circular, deep, subcylindric." Shell diameter 7-10 mm, average of ten specimens, 8.91 mm, shell height 3-5mm, whorls 4.0-4.5. Hendricks (1998) reported range in diameter of 16 live shells = 2.5-8.5 mm, nine dead shells = 8.0-9.6 mm. Shells from the Swan Range may average slightly larger in diameter: average of 13 was 9.4 mm, range 5.7-11.4 mm (Hendricks unpublished data); average of four was 9.3 mm, range 8.5-11.1 mm (Fairbanks 2002).

Reproductive biology: Hermaphroditic; reproductive anatomy described in Fairbanks (2002). There are no descriptions of reproductive behavior and its seasonal occurrence. Lifespan is unknown. Age/size at reproductive maturity is unknown.

Ecology: Occupies open talus slopes at high elevations near and above treeline (Elrod 1902, 1903b, Hendricks 1998). Vegetation at and near the alpine type locality on East St. Marys Peak in the Mission Mountains (Hendricks 1998) includes the wild flowers snow cinquefoil (*Potentilla nivea*), mountain avens (*Dryas octopetala*), alpine sorrel (*Oxyria digyna*) and moss campion (*Silene acaulis*). Subalpine fir (*Abies lasiocarpa*) is present at the margins of the subalpine site above Lower Rumble Lake in the Swan Range (Hendricks unpublished data). Rock substrate at all known sites is limestone. Live shells are found on surfaces of limestone

blocks, but often in the absence of direct sunlight (shaded areas and undersides of smaller blocks). Block size where *O. alpina* was found on St Marys Peak averaged 20 x 30 cm square and 4-8 cm thick (Hendricks 1998), block size at the Swan Range site ranged from 15 x 15 x 4 cm to 1 $m^3$ (Hendricks unpublished data). Some soil development and leaf litter was present at each site where live snails were found; one group of live snails was found in leaf litter near the base of snow cinquefoil partially protected overhead by rock. Food habits are unknown.

### C. Range and Known Sites

*Oreohelix alpina* is known from three sites (Fig. 3, Appendix B) in two counties (Elrod 1902, 1903b, Hendricks 1998, Fairbanks 2002). The type locality is East St. Marys Peak in the Mission Mountains of Lake County, from 2710 m (8900 ft) to 2865 m (9400 ft) elevation. The second site in the Mission Mountains is more extensive, and includes West McDonald Peak, the summit area of McDonald Peak, and the slopes of McDonald Peak above Duncan Lake, all in Lake County, from 2255 m (7400 ft) to 2957 m (9700 ft) elevation. The third site is above Lower Rumble Lake in the Swan Range, Missoula County, at 2195 m (7200 ft) elevation.

The known sites have been visited infrequently, probably because of difficult access. Prior to 1997, the species had not been reported at either Mission Mountains site since 1952 (specimen in the Field Museum of Natural History, Chicago), and there remain few collections of this species. The Swan Range site was not discovered until 1975, and *O. alpina* had not been documented again at this locality until 2000. Other sites within each mountain range are likely to exist. Additional populations may be discovered in portions of the Bob Marshall Wilderness.

### D. Species Abundance

*Oreohelix alpina* is a local endemic restricted to the Mission Mountains and nearby Swan Range. The species was relatively abundant at some locations within sites of occurrence (Elrod 1902, Hendricks 1998). However, no population estimates are available, and nothing is known regarding population trends at any site.

## Current Status

### A. Why Species is of Conservation Concern

The Alpine Mountainshell (*Oreohelix alpina*) is a Species of Concern in Montana because it is a local endemic so far documented at three sites, despite several decades of widespread collecting in the region by Dr. R. B. Brunson and students (Frest and Johannes 1995). Population size and trends are unknown. Recommended for Federal listing by Frest and Johannes (1995).

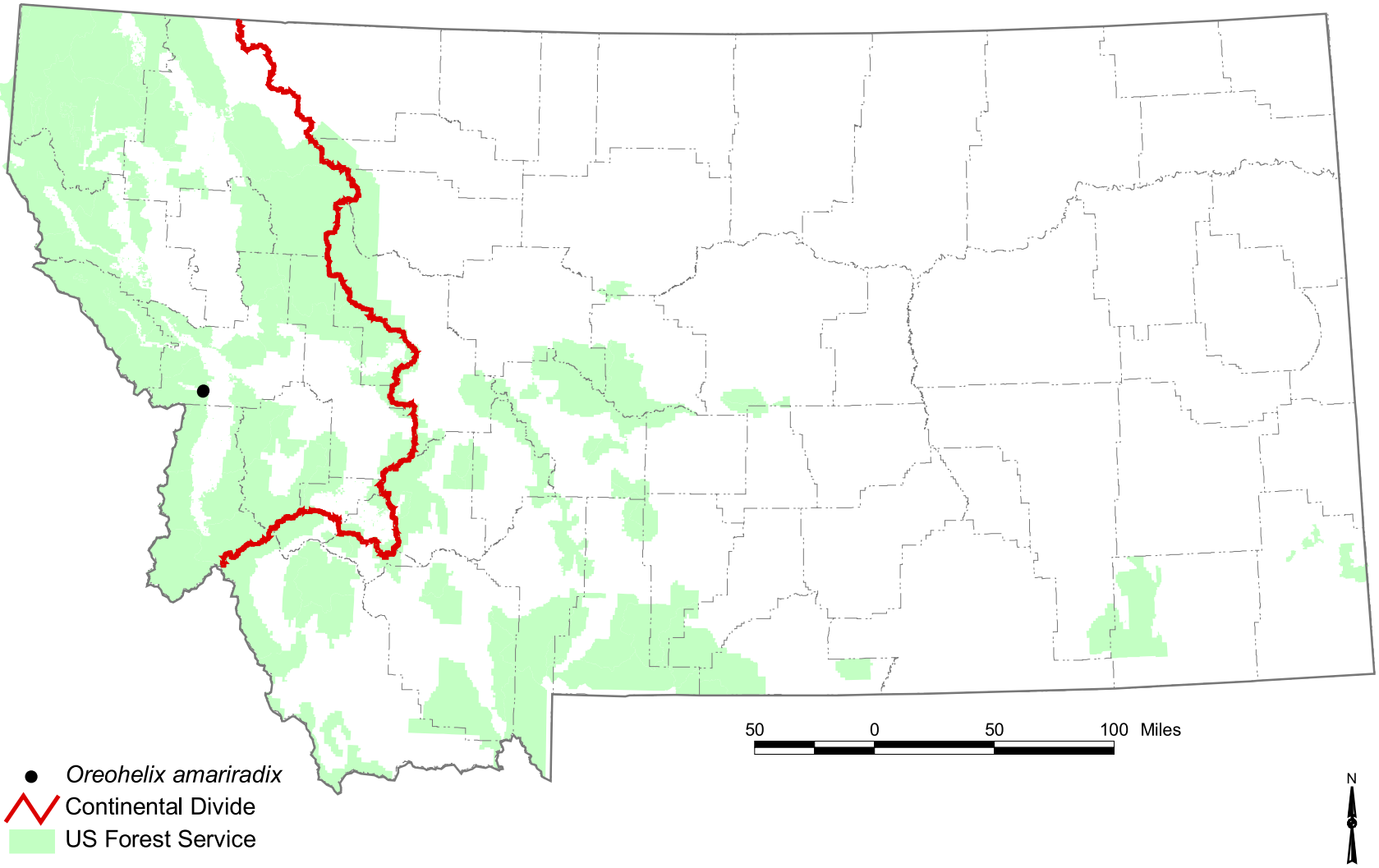
## C. Threats

Occupied habitat (alpine and high-elevation limestone talus) is not threatened by current land use practices. Probably the greatest threat to species persistence is climate change.

## C. Distribution Relative to Land Allocations

The two known sites in the Mission Mountains are in the Confederated Salish and Kootenai Tribes Mission Mountains Tribal Wilderness. The Swan Range site is on the Flathead National Forest (Swan Lake Ranger District). Additional populations are possible on adjacent Tribal and Forest Service lands.

**Figure 4. Distribution of *Oreohelix amariradix* in Montana.**



**SPECIES:** *Oreohelix amariradix* (Bitterroot Mountainsnail)

**Heritage Rank**: G1G2, S1S2

**Natural History**

**A. Taxonomy**

Family: Oreohelicidae
*Oreohelix amariradix* Pilsbry, 1934

Originally identified by Elrod (1901a, 1902, 1903b) as a "small variety" of *Oreohelix* (=*Pyramidula*) *strigosa* from the Bitterroot Mountains, but described by Pilsbry (1933) as a full species of the *O. strigosa* group, based only on dead shells. Fairbanks' (1980) analysis of the internal anatomy confirmed Pilsbry's designation. Pilsbry (1939) placed all *Oreohelix* in the Xanthonycidae.

**B. Species Description**

Morphology: Pilsbry (1933, 1939) describe the shell as "openly umbilicate, the umbilicus contained about 4 times in the diameter; biconvex with the periphery rather sharply angular, the angle disappearing on the last third of a whorl. Whorls 5 1/3, the embryonic 2 1/3 moderately convex and nearly smooth. Susequent whorls rather coarsely and irregularly wrinkle-striate, without spiral striation, but there is often a spiral impression above the suture on the penult whorl. The last whorl descends shortly in front. Aperture rather strongly oblique, . . . The specimens . . . show a reddish band immediately below the periphery, another a short distance above it." Shell height 8.5 mm, diameter 14.5 mm. Elrod (1903b) gives height of 10 shells 5.3-7.4 mm, diameter 11.9-16.7 mm; number of whorls 4.8-5.4. Fairbanks (1980) gives height of 6.9-10.9 mm and diameter of 12.8-17.9 mm for 21 specimens from another site nearby; number of whorls 4.75-5.5.

Reproductive biology: Hermaphroditic (Fairbanks 1980). No description of reproductive behavior and its seasonal occurrence in natural settings. Life span is unknown. Age/size of reproductive maturity is not described; in captivity young born live after adults overwintered.

Ecology: This species occupies small talus slides, primarily the basal portions (Frest and Johannes 1995), scattered among open grassy, south-facing slopes that become quite dry in mid-summer (Elrod 1903b, Fairbanks 1980). Vegetation at one site included bunch grasses, ponderosa pine (*Pinus ponderosa*), serviceberry (*Amelanchier alnifolia*), and ninebark (*Physocarpus malvaceus*). Food habits are unknown.

**C. Range and Known Sites**

*Oreohelix amariradix* is known only from the Lolo Creek drainage near Fort Fizzle, Missoula County (Fig. 4, Appendix B) at about 1070 m (3500 ft) elevation. Elrod (1903b) gave the

elevation at the type locality as 1524 m (5000 ft), but this is likely an error, as Lolo Pass is < 100 m elevation above this contour, nor does habitat at that elevation fit the description. Reported records along the Clark Fork River at Ravenna and Nimrod (Frest and Johannes 1995) appear to be an error, perhaps confused with locations for *O. carinifera* (see next species account), as no documentation was found for *O. amariradix* at these sites.

The known sites have been visited infrequently. Attempts by Frest and Johannes (1995) to locate living animals in 1994 were unsuccessful, although these authors state that the species is extant at two Lolo Creek drainage sites. Given their comments, and earlier ones by Elrod (1901), populations other than those listed in Appendix B may exist in the Lolo Creek area.

### D. Species Abundance

*Oreohelix amariradix* is a local endemic restricted to the Bitteroot Mountains. There are no published estimates of population size or relative abundance. There may be an overall declining trend in absolute abundance, given Frest and Johannes' (1995) comments about local extinctions.

## Current Status

### A. Why Species is of Conservation Concern

The Bitterroot Mountainshell (*Oreohelix amariradix*) is a Species of Concern in Montana because it is a local endemic so far documented only in the Lolo Creek drainage , despite several decades of collecting in the region by Dr. R. B. Brunson and students (Frest and Johannes 1995). Population size and trends are unknown.

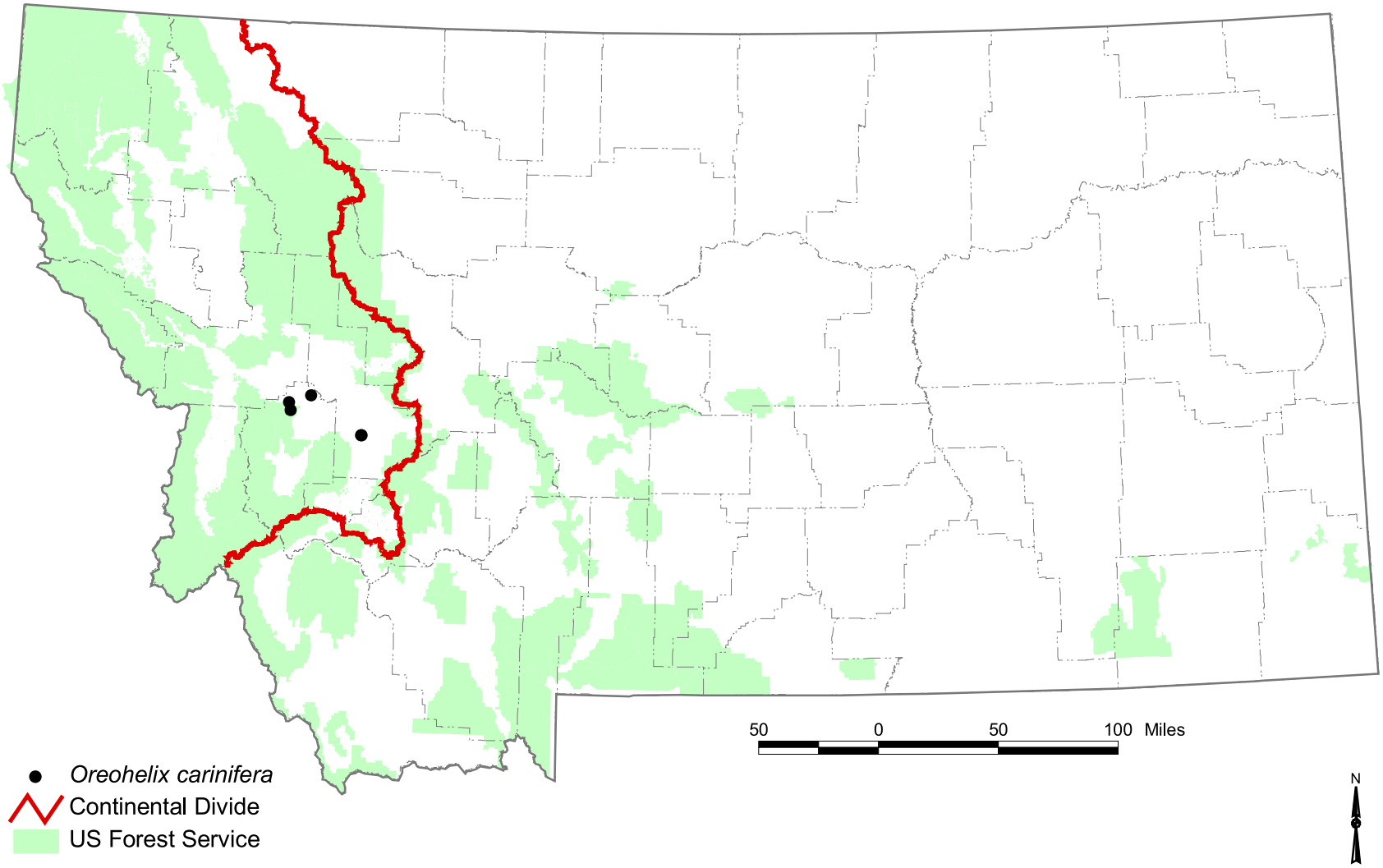
### B. Threats

Habitat occupied by *Oreohelix amariradix* (low elevation talus in slopes of open ponderosa pine) is threatened by logging, grazing, weed control, highway development, home development, and fire. The impact of fire retardant on this and other terrestrial mollusks in not known. Little is known about this species, including its susceptibility to disturbance.

### C. Distribution Relative to Land Allocations

The known sites (Appendix B) are on or near Lolo National Forest lands, as well as private timber company lands. It is quite possible that additional populations occur on both, as well as other private lands. None of the sites have special protection.

**Figure 5. Distribution of *Oreohelix carinifera* in Montana.**



**SPECIES:** *Oreohelix carinifera* (Keeled Mountainsnail)

**Heritage Rank**: G1, S1

**Natural History**

**A. Taxonomy**

Family: Oreohelicidae
*Oreohelix carinifera* Pilsbry, 1912

Affinities of this species are with the *Oreohelix yavapai* group (Pilsbry 1933, Frest and Johannes 1995), and based primarily on the internal anatomy. Pilsbry (1939) placed all *Oreohelix* in the Xanthonycidae.

**B. Species Description**

Morphology: Pilsbry (1912, 1933, 1939) describes the shell as "lenticular, carinate, umbilicate, the umbilicus contained 4 1/3 times in the diameter. The whorls increase slowly, the first 2 ½ strongly convex, the rest strongly convex around the upper (inner) part, becoming concave near the outer (peripheral) edge. The embryonic whorls are very finely obliquely striate; later whorls rather coarsely wrinkle-striate, with some weak spiral striae in places; the last whorl is concave above and below the peripheral keel, descends very little or not at all in front, . . . The aperture is about as high as wide, and shows a slight angle at the end of the keel." Shell diameter 9-12 mm; shell height 5-7 mm; whorls 4 ¼ - 5. The internal anatomy is described in Pilsbry (1933, 1939).

Reproductive biology: Hermaphroditic (Pilsbry 1933, 1939). There is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown.

Ecology: This species occupies small limestone outcrops and sandy limestone soils on arid slopes with sparse vegetation cover; described sites have been south facing (Frest and Johannes 1995, L. Fairbanks personal communication). Vegetation at sites includes open stands of sagebrush (*Artemisia*), juniper (*Juniperus*) and Douglas-fir (*Pseudotsuga menziesii*). Individuals have often been found under shrubs and junipers. Food habits are not described.

**C. Range and Known Sites**

*Oreohelix carinifera* is known in Montana from four sites in the Clark Fork River drainage, Powell and Granite counties (Fig. 5, Appendix B) at 1250-1480 m (4100-4850 ft) elevation. Frest and Johannes (1995) found the species at a portion of the type locality at Garrison, but failed to at another former location near Beavertail Hill where the species was present in 1975. There have been few or no additional searches for this species at former sites in recent years.

In August 2002, however, dead shells were found at a new site in the Garnet Range (personal observation), indicating that additional sites are possible.

Both Pilsbry (1939) and Frest and Johannes (1995) listed *O. carinifera* as endemic to Montana, but the species is on the Wyoming checklist (Beetle 1989) for Park County. Interestingly, Beetle (1961) earlier identified this species from the Big Horn Mountains in Big Horn and Washakie counties, of which neither location appeared on her 1989 state checklist. It is assumed in the present report that *Oreohelix carinifera* is a local endemic in Montana, as stated by Frest and Johannes (1995); the Wyoming material needs reexamination by experts for final determination, as there are other small *Oreohelix* species present in that portion of Wyoming with which *O. carinifera* might be confused.

### D. Species Abundance

*Oreohelix carinifera* is a local endemic restricted to the upper Clark Fork River drainage. There are no published estimates of population size or relative abundance. Pilsbry (1912) noted that where the shells were "so abundant as to attract the attention of non-conchological naturalists" (p. 88) there are plenty of living snails to be found nearby (the first collection was made by two entomologists). Frest and Johannes's (1995) limited success at locating the species in the last decade, including finding dead shells where live ones were absent, suggests that population sizes may be in recent decline, with possible extinctions at some sites.

## Current Status

### A. Why Species is of Conservation Concern

The Keeled Mountainshell (*Oreohelix carinifera*) is a Species of Concern in Montana because it is a local endemic so far documented only in the upper Clark Fork River drainage between Garrison and Missoula, despite several decades of collecting in the region by Dr. R. B. Brunson and his students (Frest and Johannes 1995). Population size and trends are largely unknown.

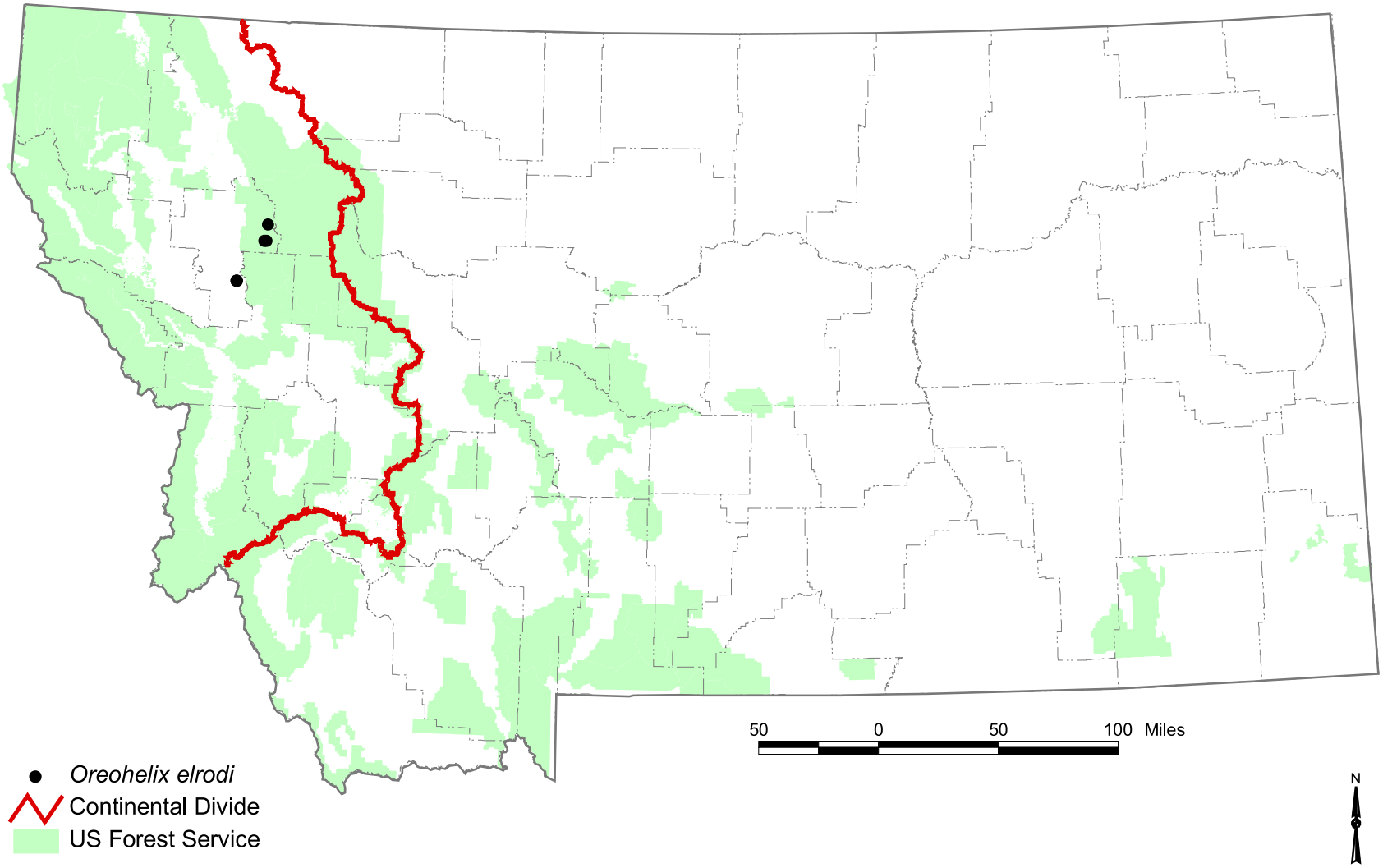
### B. Threats

Habitat occupied by *Oreohelix carinifera* (low-elevation slopes of open juniper and Douglas-fir) is threatened by logging, grazing, weed control, highway development, home development, and fire. The impact of fire retardants on this and other terrestrial mollusks in not known. Little is known about this species, including its susceptibility to disturbance.

### C. Distribution Relative to Land Allocations

The known sites are on or near private timber land, Lolo National Forest land, state land, Bureau of Land Management land, and private non-timber land. None of these sites have special protection.

**Figure 6. Distribution of *Oreohelix elrodi* in Montana.**



**SPECIES:** *Oreohelix elrodi* (Carinate Mountainsnail)

**Heritage Rank**: G1, S1

**Natural History**

**A. Taxonomy**

Family: Oreohelicidae
*Oreohelix elrodi* (Pilsbry, 1900)

Originally named *Pyramidula elrodi* by Pilsbry (1900). Affinities of this species are with the *Oreohelix strigosa* group (Pilsbry 1933, Frest and Johannes 1995), based on the internal anatomy (see Pilsbry 1939); additional description of the internal anatomy is available in Fairbanks (1984). Pilsbry (1939) placed all *Oreohelix* in the Xanthonycidae.

**B. Species Description**

Morphology: Pilsbry (1900, 1939) describes the shell as "strongly depressed, biconvex, acutely carinate, with open umbilicus contained about 4 times in the diameter; pale vinaceous fawn color to nearly white (under a fugacious light brownish cuticle which is lost in all adult shells seen). Spire low conoidal, often much depressed. Embryonic shell of 2 1/3 to 2 2/3 whorls, the first smooth, the rest varying from unevenly striate to finely costellate. Later whorls are coarsely sculptured with rude, unequal, retractive ribs, usually narrower than their intervals, which are densely and finely striate spirally. . . . The last whorl descends shortly in front. Aperture angular at termination of the keel." Shell diameter 21-28 mm (Pilsbry 1939), 17.4-26.0 mm (Fairbanks 1984), 4.1-22.6 mm (Hendricks 1998); shell height 8.8-13.3 mm (Pilsbry 1939), 8.4-13.1 mm (Fairbanks 1984); whorls 5-5 ½ (Pilsbry 1939), 5-5 ¾ (Fairbanks 1984). Shell diameter of new-born young 3.6-3.7 mm; whorls 2.3-2.5 (Hendricks unpublished data). The internal anatomy is described in Pilsbry (1939) and Fairbanks (1984).

Reproductive biology: Hermaphroditic (Pilsbry 1939, Fairbanks 1984). There is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown; a captive adult 18.2 mm diameter gave birth to 4 young after overwintering (Hendricks unpublished data).

Ecology: This species occupies course talus, typically on south-facing slopes, and usually with sparse canopy of ponderosa pine (*Pinus ponderosa*), mountain ash (*Sorbus*) and serviceberry (*Amelanchier*) (Frest and Johannes 1995). Hendricks (1998) described vegetation at three talus sites in the Mission Range, each with 0% canopy cover in the search areas, as bordered by Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine with pockets of water birch (*Betula occidentalis*), quaking aspen (*Populus tremuloides*) and mock orange (*Philadelphus lewisii*). At the two Swan Range locations, portions of the occupied terrain (Hendricks unpublished data) are in talus under a forest canopy variably composed (depending on

microsite) of Douglas-fir, ponderosa pine, quaking aspen, western red cedar (*Thuja plicata*), paper birch (*B. papyrifera*) and western larch (*Larix occidentalis*); canopy cover is 0-10%.

Elrod (1902) considered *O. elrodi* to be "a shell of the rocks" (p. 117), present on the surface of exposed talus during favorable conditions, and present down among the stones when conditions become dry (Elrod 1903a). During favorable surface conditions (wet, 10-17ºC) live individuals are found attached to rocks near the surface but more often are present on organic litter accumulations within the talus; some aestivating mature individuals (18-21 mm diameter) are found near the talus surface during dry and warm (21-23ºC) conditions (Hendricks 1998). Food habits are not described, but presence on organic litter indicates *O. elrodi* may be a detritivore.

Occupied talus at the Mission Range site is described by Berry (1955) and Frest and Johannes (1995) as limestone. However, Hendricks (1998) found *O. elrodi* in this mountain range at sites comprised mostly of diorite and/or argillite; rock type at the two occupied sites in the Swan Range is also argillite (Hendricks unpublished data). Clast (fragment) size of the rocks comprising occupied talus ranges from 10 x 20 x 10 cm to 1 $m^3$ at the Mission Range sites (Hendricks 1998), and 10 x 10 x 10 cm to 0.5 x 0.5 x 0.5 m at the Swan Range sites (Hendricks unpublished data). Measured slope at occupied sites in both mountain ranges was 25-36º (Hendricks 1998, unpublished data). How deep into talus slopes this species occurs is unknown, but live individuals were found up to a meter below the surface at the Mission Range microsite co-occupied by *Discus brunsoni* (see Hendricks 1998).

**C. Range and Known Sites**

*Oreohelix elrodi* is endemic to northwestern Montana, known from three sites in Lake County: one (the type locality) in the McDonald Lake cirque on the west side of the Mission Range at 1067-1524 m (3500-5000 ft) elevation (Elrod 1902 states shells occur up to 2286 m or 7500 ft elevation), two on the west side of the Swan Range at 1158-1295 m (3800-4250 ft) elevation along Lion and Goat creeks (Fig. 6, Appendix B). Live animals were found at the type locality in the Mission Range as recently as 1997 (Hendricks 1998), and in 1999 at both the Lion Creek site and the Goat Creek site (which was discovered in 1999). There have been few or no additional searches for this species at the above sites, and no additional surveys for new localities in either mountain range.

**D. Species Abundance**

*Oreohelix elrodi* is a local endemic restricted to the Mission and Swan ranges. There are no published estimates of population size. Elrod (1901-1902, 1902, 1903a) stated dead shells were abundant in many locations on the slopes above McDonald Lake but live animals were relatively uncommon sometimes. Live *O. elrodi* were 4-6 times more abundant than *Discus brunsoni* near the talus surface in the microsite where the two species are sympatric. Among the three sites, live individuals were found at a rate of 0.167/min on 1 July at the type locality co-occupied by *D. brunsoni*, 0.174/min on 19 May at Lion Creek, and 0.350/min on 9 June at Goat Creek; conditions were overcast, wet and 7-11ºC at the time of the searches (Hendricks

1998, unpublished data). Population trends are unknown, but the species has persisted at the type locality for a century following its discovery in 1899 (Elrod 1903a).

## Current Status

### A. Why Species is of Conservation Concern

The Carinate Mountainshell (*Oreohelix elrodi*) is a Species of Concern in Montana because it is a local endemic so far documented at only three sites in the Mission and Swan ranges of Lake County, despite several decades of collecting in the region by Drs. M. J. Elrod and R. B. Brunson and their students (Frest and Johannes 1995). Population size and trends are unknown.

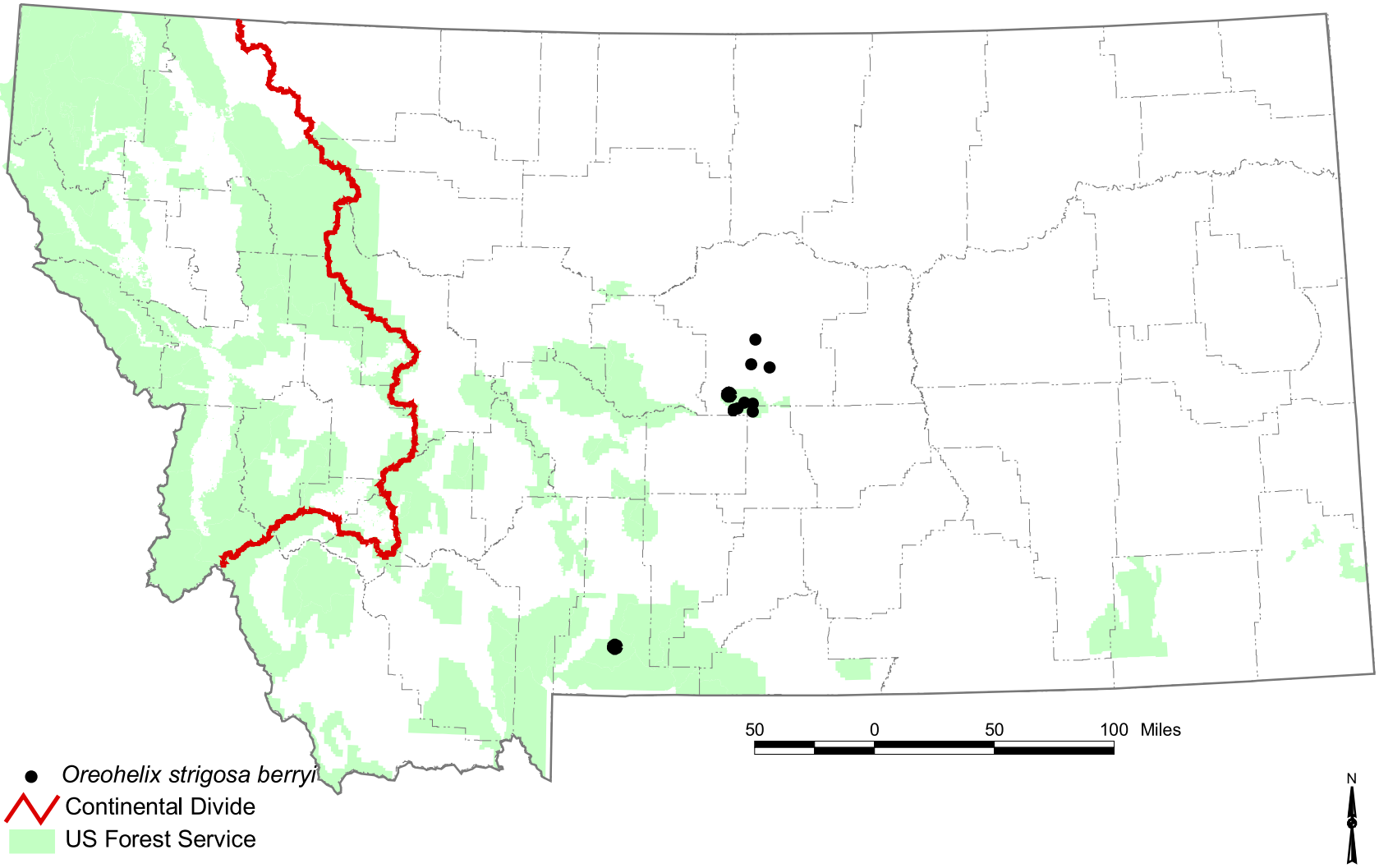
### B. Threats

Habitat occupied by *Oreohelix elrodi* (low-elevation slopes of mixed conifers, especially Douglas-fir, ponderosa pine and western larch) is threatened to some extent by logging, grazing, and fire, although occupied habitat is often in talus surrounded by mixed coniferous forest. Habitat requirements and food habits are poorly understood, however. Fire suppression efforts (especially use of fire retardants) and talus destabilization (trail maintenance, modification) could have negative impacts, as could chemical control of weeds.

### C. Distribution Relative to Land Allocations

The type (and only) locality in the Mission Range is in the Confederated Salish and Kootenai Tribes Mission Mountains Tribal Wilderness. A major hiking and packing trail bisects the site. The Lion Creek site in the Swan Range occupies lands administered by Plum Creek Timber Company and the Swan Lake Ranger District of the Flathead National Forest; a major hiking trail bisects the site. The Goat Creek site in the Swan Range occupies lands administered by the Swan Lake Ranger District of the Flathead National Forest. It is a small talus patch just upslope from FS Road 9530 in an area where logging has occurred previously.

**Figure 7. Distribution of *Oreohelix strigosa berryi* in Montana.**



**SPECIES:** *Oreohelix strigosa berryi* (Berry's Mountainsnail)

**Heritage Rank**: G5T2, S1S2

**Natural History**

**A. Taxonomy**

Family: Oreohelicidae
*Oreohelix strigosa berryi* (Pilsbry, 1915)

Originally described as a subspecies of *Oreohelix cooperi* but changed in 1933 to a subspecies of *O. strigosa* (Pilsbry 1933, Henderson 1936), with *cooperi* also reduced to a subspecies of *O. strigosa*. External and internal anatomy indicates *O. strigosa berryi* is distinct to the subspecies level (Pilsbry 1933, 1939, Frest and Johannes 1993). Beetle (1989) considered this subspecies a form of *O. pygmaea*, but Frest and Johannes (1993) separate the forms in the Black Hills on the basis of shell morphology. Pilsbry (1939) placed all *Oreohelix* in the Xanthonycidae.

**B. Species Description**

Morphology: Pilsbry (1939) describes the shell as having " the same shape characteristic of *O. cooperi* except that the last whorl is distinctly angular in front, the angle disappearing on the last half or third, leaving the periphery rounded. Color cinnamon to snuff brown, from third whorl profusely marked with white patches and narrow streaks; last whorl having a chocolate band below the periphery . . . The surface is irregularly striate and shows traces of spiral striation in places. Whorls 4 1/3, all convex. Embryonic shell of nearly two whorls, which are finely striate and covered with very fine spirals, the last half of the second whorl having distinct spiral striae. Umbilicus narrow, contained 5 ½ times in the diameter of the shell" (p. 445-446). Frest and Johannes (1993) add "full adult with about 5-5 1/4 whorls; shell low dome-shaped . . ." (p. 76). Shell diameter 7-13 mm (types 9.3 and 9.4 mm); shell height of types 6.1 and 6.3 mm (Pilsbry 1939). Internal anatomy described in Pilsbry (1933, 1939).

Reproductive biology: Hermaphroditic (Pilsbry 1933, 1939). There is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown.

Ecology: Found among small loose rock, shrubbery, and under creeping juniper (*Juniperus horizontalis*) on west-facing canyon slopes at the type locality in the Big Snowy Mountains, and under sticks and logs in moister locations in the same mountain range (Berry 1916). This snail was present in the Mammoth area of Yellowstone National Park on a north exposure of limey soil with plenty of cover, but neither very wet nor dry (Henderson 1936). Substrate typically is derived from limestone (Frest and Johannes 1993, 1995). In the Black Hills and Bear Lodge Mountains of Wyoming and South Dakota, it occurs in mixed and open ponderosa pine (*Pinus ponderosa*) forests with relatively thin litter, often with aspen (*Populus*

*tremuloides*) and birch (*Betula*) in the canopy, and violets (*Viola*) and Canada dogwood (*Cornus canadensis*) in the understory (Frest and Johannes 1993); the deciduous tree component was relatively important for the occurrence of this subspecies.

### C. Range and Known Sites

*Oreohelix strigosa berryi* is documented from several locations in and near the Big Snowy Mountains of Fergus and Golden Valley counties, Montana (Fig. 7, Appendix B), and more recently (Hendricks unpublished data) from the Judith Mountains, also in Fergus County, and the vicinity of Montanopolis in the Absaroka Mountains, Park County (Frest and Johannes 1995); elevation ranges from 1295-2438 m (4250-8000 ft). Also documented in Wyoming in Yellowstone National Park near Mammoth (Henderson 1933, 1936, Pilsbry 1939) and in the Black Hills National Forest of Wyoming and South Dakota (Frest and Johannes 1993).

### D. Species Abundance

*Oreohelix strigosa berryi* in Montana has been fully documented only in the Big Snowy Mountains. Population sizes are not reported for any of the Montana locations, nor have most of these sites been revisited in recent decades. Berry (1916) found it to be the most conspicuous land snail near the mouth of Swimming Woman Creek Canyon in the Big Snowy Mountains. Colonies outside of the Big Snowy Mountains generally appear to be small and isolated (Frest and Johannes 1993), although the recent collection of shells in the Judith Mountains (Hendricks unpublished data) indicate colonies, some fairly large, may be present in some of the other "island mountains ranges" of eastern Montana. Henderson (1936) said the species occurred in abundance near Mammoth in Yellowstone National Park, Wyoming. Population trends are unknown for any locality.

## Current Status

### A. Why Species is of Conservation Concern

Berry's Mountainshell (*Oreohelix strigosa berryi*) is a Species of Concern in Montana because it is a relict subspecies so far documented in Montana at ten localities in three mountain ranges, and only present in two additional areas outside of Montana in Wyoming and South Dakota (Yellowstone National Park, Black Hills National Forest) despite several decades of collecting in the region by Dr. R. B. Brunson and Stillman Berry. Population size and trends in Montana are unknown, but outside of Montana where intensive surveys have been undertaken in recent years (Frest and Johannes 1993) this subspecies appears to exist in only a few small colonies.

### B. Threats

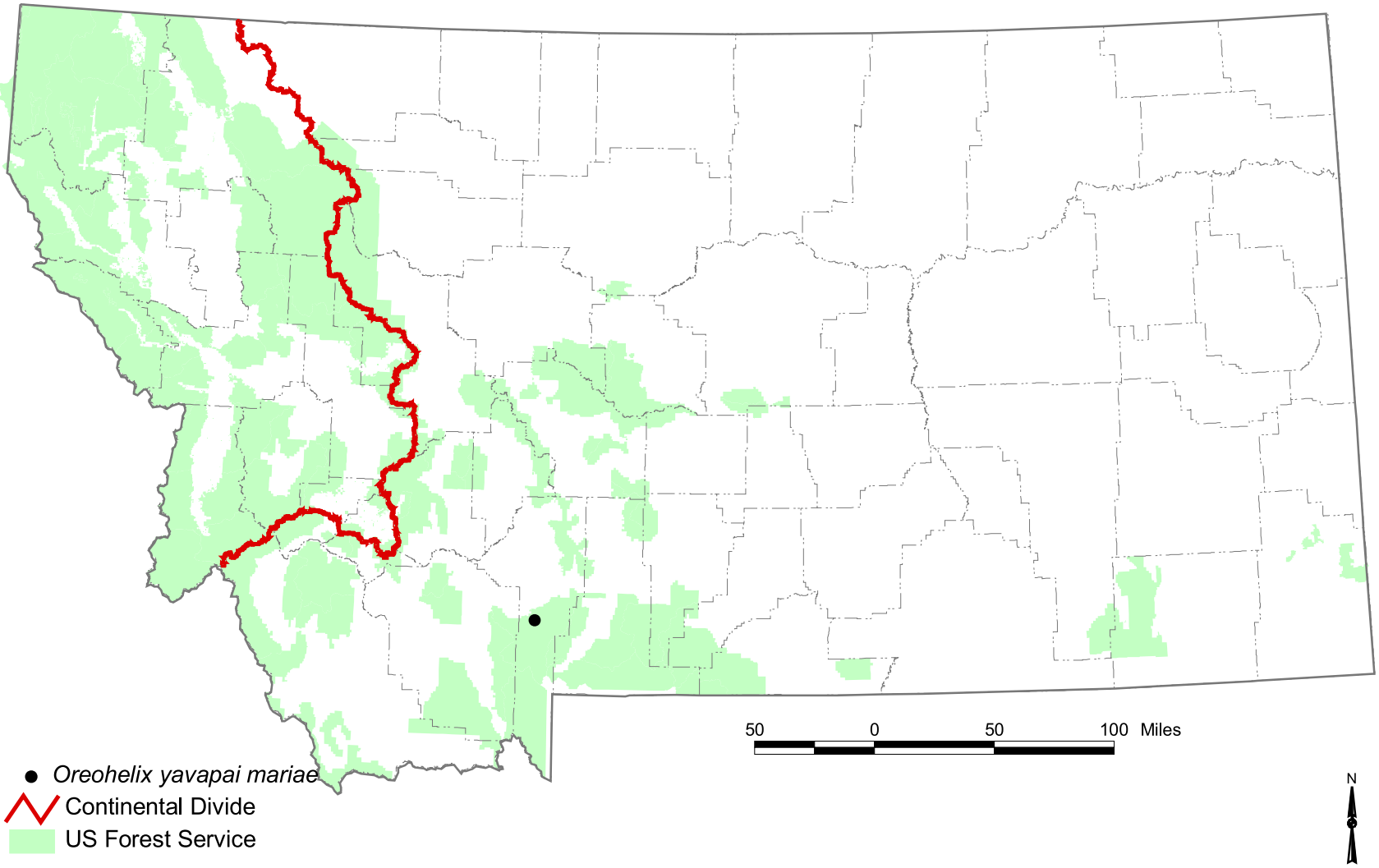
Habitats occupied by *Oreohelix strigosa berryi* are may be threatened by logging and grazing, and possibly weed control and mining, but most documented localities have not been revisited in decades, so current threats are unknown. Fire and fire suppression efforts could have negative impacts (numerous dead shells found in the Judith Mountains were in a decade-old burn).

Logging and grazing threaten the Black Hills National Forest colonies (Frest and Johannes 1993). Habitat requirements and food habits are poorly understood. Colonies may be local and small.

**C. Distribution Relative to Land Allocations**

The type locality (Swimming Woman Creek Canyon) and all other known locations (six total) in the Big Snowy Mountains are on lands administered by the Musselshell Ranger District of the Lewis and Clark National Forest. Two other sites north of the Big Snowy Mountains apparently are on private and possibly state land. The site in the Judith Mountains is on land administered by the Lewistown Field Office of the Bureau of Land Management. The Park County site is on land administered by the Livingston Ranger District of the Gallatin National Forest.

**Figure 8. Distribution of *Oreohelix yavapai mariae* in Montana.**



**SPECIES:** *Oreohelix yavapai mariae* (Gallatin Mountainsnail)

**Heritage Rank**: G4?T1, S1

**Natural History**

**A. Taxonomy**

Family: Oreohelicidae
*Oreohelix yavapai mariae* Bartsch, 1916

The original description of this taxon by Bartsch (1916) and his placement as a subspecies of *Oreohelix yavapai* are still valid. Pilsbry (1939) and Frest and Johannes (1995) consider this taxon distinct from another subspecies, *O. yavapai extremitatis*, that is present in the Big Horn Mountains, Wyoming, and the nearby Bridger Range, Montana. Pilsbry (1939) placed all *Oreohelix* in the Xanthonycidae.

**B. Species Description**

Morphology: Bartsch (1916) describes the shell as "decidedly depressed helicoid, almost lenticular, flesh colored, with a narrow brown band on the upper surface, which is a little nearer the peripheral cord than the suture, and a second even narrower one bordering the peripheral cord on the lower surface. Nuclear whorls scarcely differentiated from succeeding turns, bearing the same sculpture as the adult whorls, but a little less strongly expressed. Periphery of the whorls provided with a cord-like keel, which becomes somewhat weakened on the last quarter of the last turn. Entire surface both above and below marked by slender thread-like incremental lines and fine spiral striations; last whorl slightly descending near the aperture. Base broadly, openly umbilicated, well rounded; a little more convex at the umbilical wall than at the lateral margin. Aperture very oblique, oval; peristome neither thickened nor reflected at the edge; parietal wall strong, rendering the peristome complete" (p. 331). Shell diameter 20.7 mm (18.3-22.5 mm; n = 9); shell height 9.2 mm (8.2-10.0 mm; n = 9); number of whorls 5.5 (5.2-5.6; n = 9). Internal anatomy not described.

Reproductive biology: Presumably hermaphroditic, but the internal anatomy is not described. There is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown.

Ecology: Present on a south-facing slope in grassy habitat near the base of a limestone outcrop (L. Fairbanks personal communication). Nothing else about the ecology of this species is known or described.

**C. Range and Known Sites**

Known only from the type locality at Squaw Creek near the mouth of Gallatin Canyon in the Gallatin Range, Gallatin County, Montana (presumably above the confluence of Squaw Creek

with the Gallatin River) at 1707 m (5600 ft) elevation (Fig. 8, Appendix B).

### D. Species Abundance

No information. Specimens have been collected at the type locality as recently as 1976 (L. Fairbanks personal communication). Population trends are unknown.

## Current Status

### A. Why Species is of Conservation Concern

The Gallatin Mountainshell (*Oreohelix yavapai mariae*) is a Species of Concern in Montana because it is known only from a single locality. Decades of collecting across Montana by R. B. Brunson, Stillman Berry, and others have revealed no additional colonies, although additional searches in the Gallatin Range may result in discovery of additional populations.

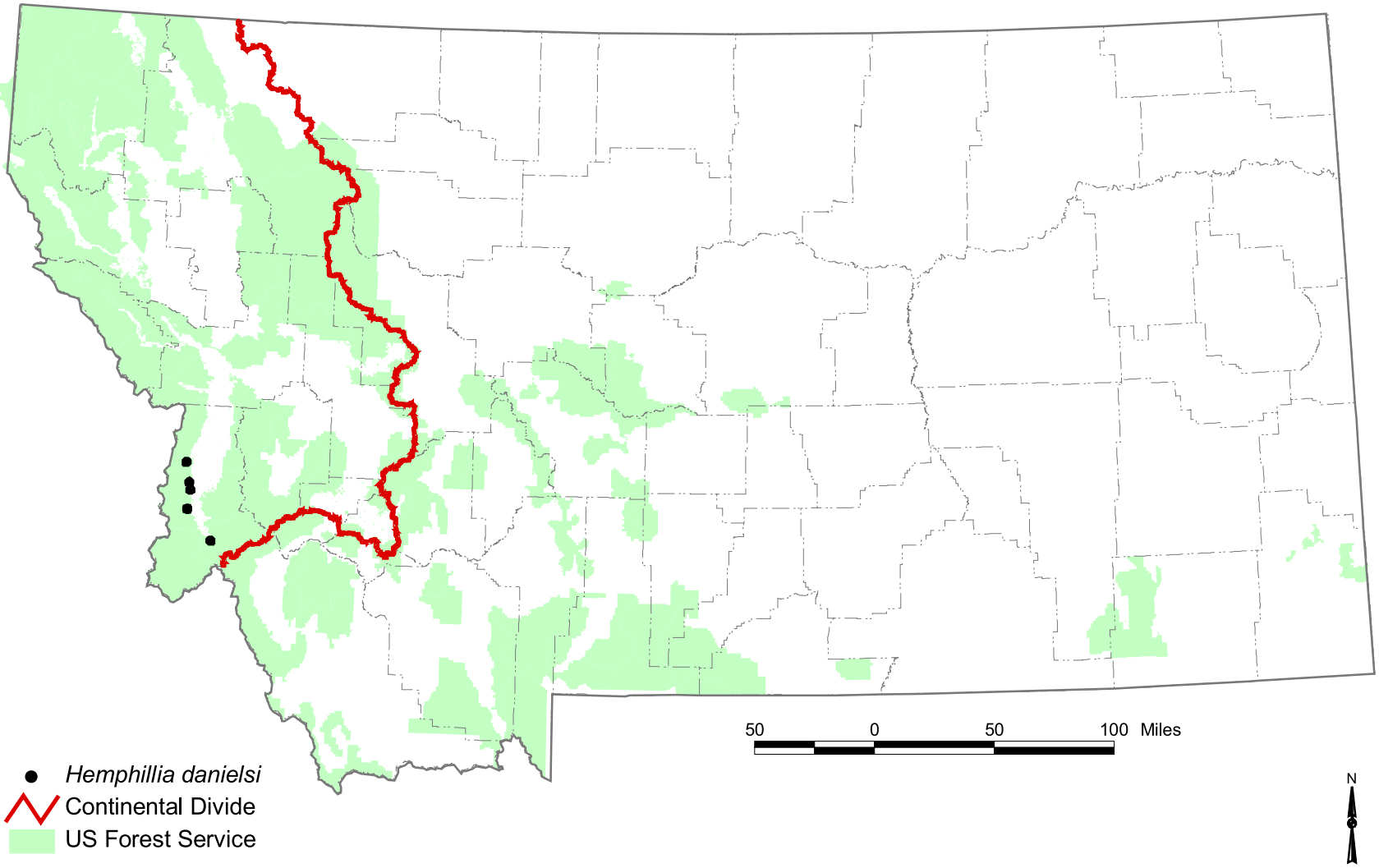
### B. Threats

Logging and road construction along the Gallatin River and Squaw Creek are likely the main threats that could impact the only known population (Frest and Johannes 1995). Fire, fire suppression, weed control, and grazing could also have negative impacts.

### C. Distribution Relative to Land Allocations

The only known site is on lands administered by the Bozeman Ranger District of the Gallatin National Forest.

**Figure 9. Distribution of *Hemphillia danielsi* in Montana.**



## SLUGS

**SPECIES:** *Hemphillia danielsi* (Marbled Jumping-slug)

**Heritage Rank**: G1G3, S1S3

**Natural History**

### A. Taxonomy

Family: Arionidae
*Hemphillia danielsi* Vanatta, 1914

The original species description by Vanatta (1914, see also Pilsbry 1948) and placement in the Arionidae are still valid. This species is the eastern-most member of a small genus restricted to the Pacific Northwest.

### B. Species Description

Morphology: Vanatta (1914, *in* Pilsbry 1948) describes *Hemphillia danielsi* as "sluglike, with the shell partly exposed, and the mantle elevated into a visceral hump, as usual in this genus. The color in formalin is yellowish-gray with bluish-black markings, but in alcohol it is white with black maculations. The shell pore is about one-third the length of the mantle. The posterior part of the foot is narrow, with a dorsal median groove and a tail pore" (p. 747). Length 3.4 cm (Vanatta 1914, Pilsbry 1948); Pilsbry considered this individual an immature. A recent specimen collected along Mill Creek (Appendix B) measured 6.4 cm (Hendricks unpublished data), and Pilsbry (1948) quotes L.E. Daniels as stating that the living slug is "about two inches [5.1 cm] long, with a high hump showing the shell" (p. 748). In live animals, and some preserved specimens, the tail portion of the foot is laterally compressed, keeled, and tipped with a horn-like projection (Hendricks personal observation; see also photos of *H. dromedarius* in Ovaska et al. 2002). Internal anatomy is described in Vanatta (1914) and Pilsbry (1948).

Reproductive biology: Hermaphroditic, based on internal anatomy; the congeneric Malone Jumping-slug (*Hemphillia malonei*) is hermaphroditic, but spermatophore delivery is sometimes non-reciprocal (Leonard and Ovaska 2002). There is no description of the reproductive behavior and biology of *H. danielsi*, but it may be similar to *H. malonei* for which there exists a recent description of breeding behavior in captivity (Leonard and Ovaska 2002). *H. malonei* captive-raised from eggs reached sexual maturity in the first year.

Ecology: There are few descriptions of the habitat occupied by this species. Frest and Johannes (1995) indicate that moderate-elevation ponderosa pine forest (*Pinus ponderosa*) is characteristic; moist valley, ravine, gorge, or talus sites are preferred (i.e., low on slopes near water). This description is supported by more recent observations (W. Leonard, B. Maxell, H. Reise personal communications). Each of the correspondents reported finding *Hemphillia danielsi* in riparian areas very near water (Appendix B). Sites included an overstory of

deciduous and coniferous trees and shrubs (*Picea engelmanii*, *Pseudotsuga douglasii*, *Populus*, *Alnus*). Rock or soils at known sites have not been described, but igneous rock types dominate the range of this species.

### C. Range and Known Sites

*Hemphillia danielsi* is virtually a Montana endemic known only from the eastern side of the Bitterroot Mountains in Ravalli County (Fig. 9, Appendix B), with the exception of one or two records a short distance west of the Bitterroot crest into Idaho (see below); the type locality is at Camas Creek. Five total sites in Montana have been documented, from Mill Creek in the north to Medicine Hot Springs in the south at elevations between 1341-1524 m (4400-5000 ft). Two of the five sites (Bunkhouse Creek, Mill Creek) were first discovered in 2001. Additional populations in the Bitterroot Mountains are likely to be discovered as more surveys are conducted. *Hemphillia danielsi* has been documented infrequently in surveys on the Idaho side of the Bitterroots (Frest and Johannes 1995); the first Idaho record apparently is that of Webb (1959) near Lolo Pass, and *Hemphillia* collected more recently at the confluence of Apgar Creek with the Lochsa River in Idaho County may be this species (W. Leonard personal communication).

### D. Species Abundance

No information. Animals were collected at the type locality as recently as 2001 (H. Reise personal communication), four individuals were found at the Bunkhouse Creek site in 2001, two individuals at the Mill Creek site in 2001 (W. Leonard, B. Maxell personal communications).

## Current Status

### A. Why Species is of Conservation Concern

The Marbled Jumping-slug (*Hemphillia danielsi*) is a Species of Concern in Montana because it is nearly a Montana endemic so far documented at but five sites in the Bitterroot Mountains of Ravalli County, despite several decades of collecting in the region by Dr. R. B. Brunson and students (Frest and Johannes 1995). Population sizes and trends are unknown.

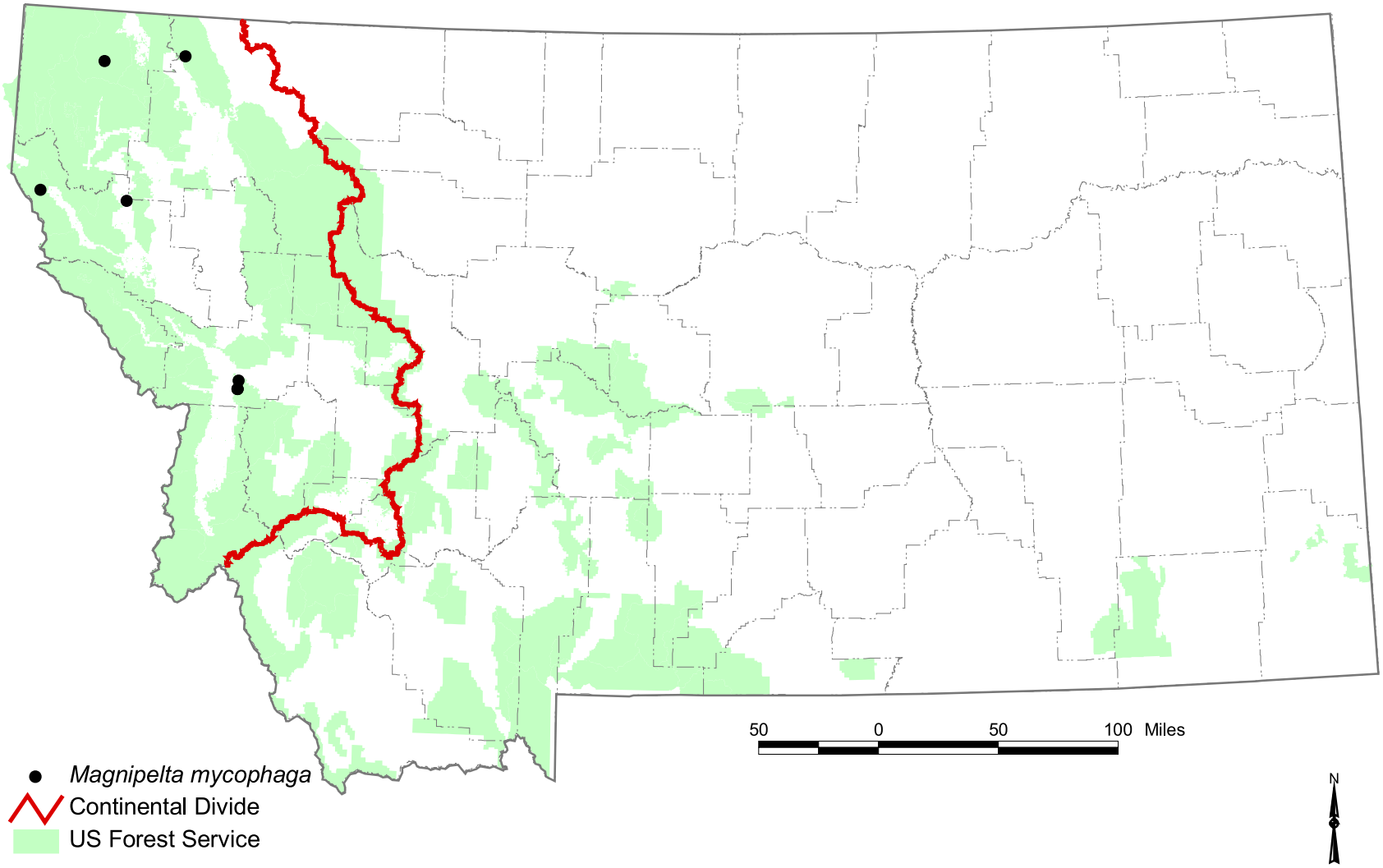
### B. Threats

Habitat occupied by *Hemphillia danielsi* (moderate elevation mixed conifer forest, often near water) is threatened by logging, grazing, fire, and possibly weed control and rural home development. The impact of fire retardant on this and other terrestrial mollusks is not known. Little is known about this species, including its sensitivity to disturbance.

## C. Distribution Relative to Land Allocations

Probably four, and possibly all, of the known sites in Montana (Appendix B) are on lands administered by the Stevensville, Darby, and Sula Ranger Districts of the Bitterroot National Forest. The specific collection site at Medicine Hot Springs is uncertain and may be on private land.

**Figure 10. Distribution of *Magnipelta mycophaga* in Montana.**



**SPECIES:** *Magnipelta mycophaga* (Spotted Slug)

**Heritage Rank**: G2G3, S1S3

**Natural History**

**A. Taxonomy**

Family: Arionidae
*Magnipelta mycophaga* Pilsbry, 1953

The original species description by Pilsbry (1953, see also Pilsbry and Brunson 1954) and placement in the Arionidae are still valid, although Webb and Russell (1977) noted possible alliance with the Camaenidae, based on anatomical features. The genus is monospecific and restricted to the interior Pacific Northwest.

**B. Species Description**

Morphology: Does not closely resemble any other described North American slug (Frest and Johannes 1995). In the original description, based on an immature specimen, Pilsbry (1953) states the appearance of *Magnipelta mycophaga* as "characterized by the structure of the mantle and foot . . . the mantle covering far the greater part of the upper surface. The mantle is free anteriorly for more than one-fourth of its length, smooth, chamois colored with an irregular black stripe on each side and elsewhere unevenly spotted with black. The quite short respiratory slit is slightly post-median on the right side. Length of mantle 16 mm. The foot is lighter colored than the mantle, spotted with black on the flanks posteriorly. It has an irregular polygonal impressed reticulation. The pedal margin is quite narrow, the pedal grooves meeting above the tail without any trace of a caudal pore. The sole is transversely wrinkled at the sides, the middle third smoother, but it is not distinctly tripartite" (p.37-38). In a second preserved and partly contracted specimen collected at a later date the mantle measured 34 mm in length, free anteriorly for 9 mm and posteriorly for 5 mm (Pilsbry and Brunson 1954); in this specimen the slit to the pneumostome was 15 mm from the anterior end of the mantle. *Magnipelta mycophaga* can be a moderately large slug; a May sample of 12 extended animals ranged from 1.5-6.7 cm (mean = 3.6 cm), a June sample of 20 animals from the same locality ranged from 1.4-8.0 cm (mean = 4.3 cm) (Brunson and Kevern 1963). Two other individuals from widely separate localities measured ca. 7.0 cm and 8.0 cm (Hendricks personal observation). Internal anatomy is described and illustrated in Pilsbry (1953), Pilsbry and Brunson (1954), and Webb and Russell (1977).

Reproductive biology: Hermaphroditic, based on internal anatomy (Pilsbry and Brunson 1954, Webb and Russell 1977). There is no description of reproductive behavior and its seasonal occurrence; Pilsbry and Brunson (1954) suggest reproduction may occur early in the year, based on finding immature animals in late May. Life span is unknown. Age/size at reproductive maturity is unknown, but Pilsbry (1953) mentioned that the type specimen, with a mantle length

of 16 mm, was immature with a genital system only partly developed, the ducts thread-like and extremely fragile.

Ecology: Found in a variety of low- to mid-elevation sites, often with water in the general vicinity. Moist, cool sites in relatively undisturbed forest with an intact duff layer, such as are found in moist valleys, ravines, and talus areas, are preferred (Frest and Johannes 1995). Forest canopy composition at sites includes *Picea engelmannii*, *Pseudotsuga menziesii*, *Pinus ponderosa*, *Pinus albicaulis*, *Larix occidentalis*, *Abies lasiocarpa*, and *Abies grandis*, often with *Alnus* present (Appendix B; Pilsbry and Brunson 1954, Brunson and Kevern 1963, Hendricks personal observation); spruce-fir appears to be the most frequent forest association. The Thompson River, Sanders County location (Appendix B) is an area of near-minimal tree canopy cover, though brushy, indicating slugs may move some distance when conditions are favorable, or that the species can persist in some relatively exposed and disturbed habitats. Often found on the ground under pieces of loose bark, logs, loose stones, and in rotted wood; surface active on cool (10-16°C), wet and overcast days, probably most active at night. Feeds on green plant material, possibly including moss (Brunson and Kevern 1963); the type specimen was found feeding on one of the larger fungi, hence the specific Latin name of the species (Pilsbry 1953).

**C. Range and Known Sites**

*Magnipelta mycophaga* is found in northwestern Montana, northern Idaho, northeastern Washington (Frest and Johannes 1995), and probably adjacent regions of British Columbia. In Montana, this species has been documented at six localities in four counties: Flathead, Lincoln, Missoula, and Sanders (Fig. 10, Appendix B). A probable seventh Montana locality, mentioned in Pilsbry and Brunson (1954) as in the Blackfoot Valley near Bonner, Missoula County, was too vague to be mapped and was not included in Appendix B; the Lincoln County site, centered on McGuire Creek in the Ural-Tweed Bighorn Sheep range (see Forrester 1960, 1962) is also poorly described in the literature, but included in Appendix B because it represents a location far removed from other reported sites. This slug species has been found at elevations between 762-1585 m (2500-5200 ft) in Montana, and up to ca. 1829 m (6000 ft) in northeastern Washington (T. Burke personal communication). The Deer Creek, Missoula County, colony site is described by Brunson and Kevern (1963) as about 400 m (440 yds) in length. Additional populations in northwestern Montana are likely to be discovered with additional survey effort, given that half of the known Montana sites were found since 1998.

**D. Species Abundance**

Almost no information. In 1954 at the Deer Creek, Missoula County site 19 individuals were found in May and 10 in June. Counts at the same locality in 1957 were 29 April: 1, 5 May: 1, 10 May: 12, 1 June: 18, 7 June: 86, 23 June: 20, 20 July: 4, 4 August: 3, 5 September: 10, 22 September: 1 (Brunson and Kevern 1963), indicating that the species may be relatively abundant in some localities. Numbers reported at other sites are 1-2 individuals, but none of these sites have been visited more than twice, nor searched thoroughly like the Deer Creek site.

Apparently the Deer Creek site has not been revisited in recent decades, but the species persists (as of 2001) at the Little Park Creek site only 5.6 km (3.5 mi) to the south.

## Current Status

### A. Why Species is of Conservation Concern

The Spotted Slug (*Magnipelta mycophaga*) is a Species of Concern in Montana because it is a regional endemic so far documented at six sites in four Montana counties, despite several decades of collecting in the region by Dr. R. B. Brunson and his students (Frest and Johannes 1995), and limited collecting by others in recent years. Population sizes and trends are unknown.

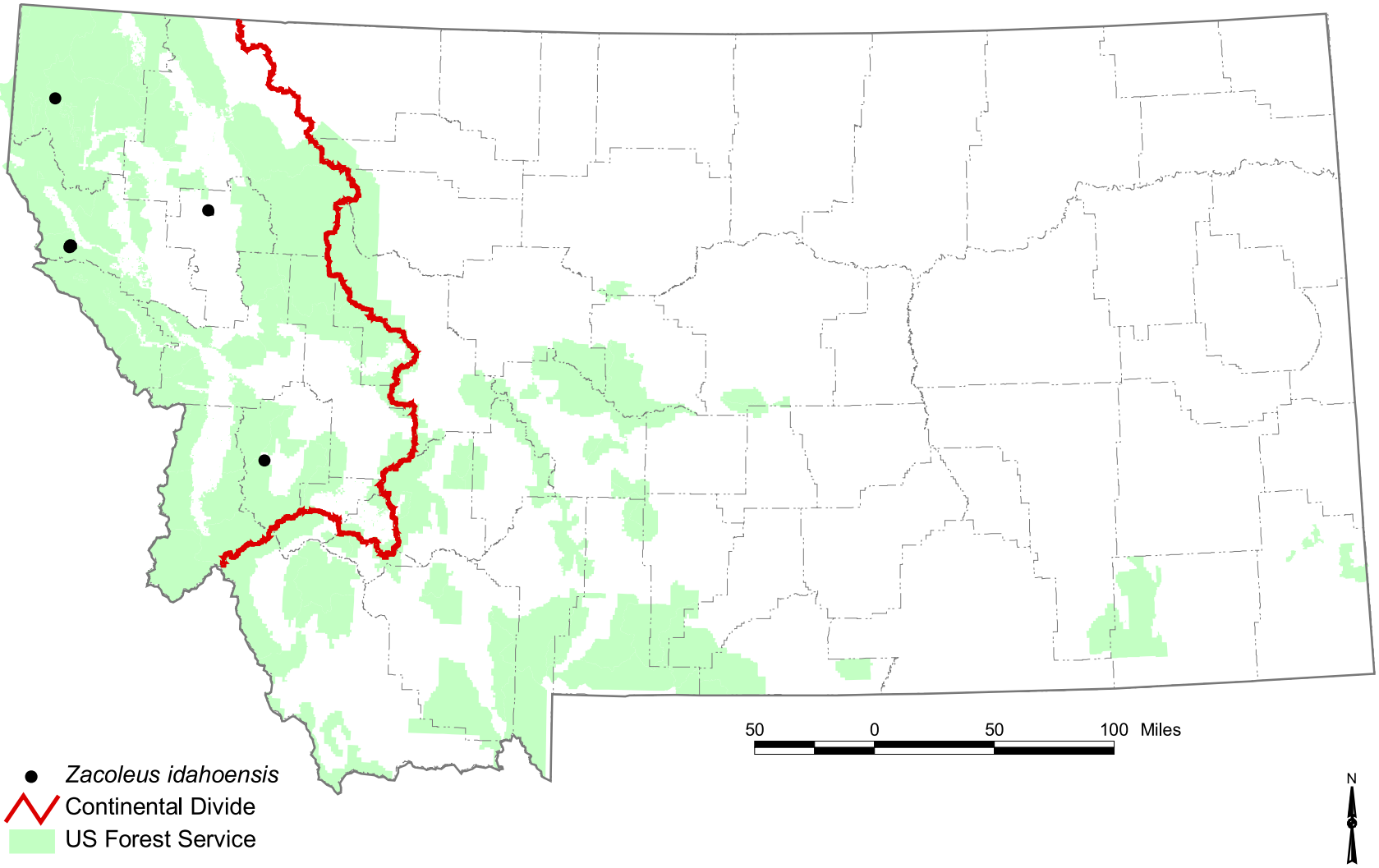
### B. Threats

Habitat occupied by *Magnipelta mycophaga* (moderate elevation mixed conifer forest, especially spruce-fir, often near water) is threatened by logging, grazing, fire, possibly rural home development, and possibly recreation and weed control. The impact of fire retardant on this and other terrestrial mollusks is not known. Little is known about this species, including sensitivity to disturbance.

### C. Distribution Relative to Land Allocations

Documented Montana sites are on lands administered by the Cabinet Ranger District, Kootenai National Forest (1 site), Rexford Ranger District, Kootenai National Forest (1 site), Glacier View Ranger District, Flathead National Forest (1 site), Missoula Ranger District, Lolo National Forest (1 site), Plum Creek Timber Company (2 sites).

**Figure 11. Distribution of *Zacoleus idahoensis* in Montana.**



**SPECIES:** *Zacoleus idahoensis* (Sheathed Slug)

**Heritage Rank**: G3G4, S2S3

**Natural History**

**A. Taxonomy**

Family: Arionidae
*Zacoleus idahoensis* Pilsbry, 1903

The original species descriptions by Pilsbry (1903, 1948) and placement in the Arionidae are still valid. The genus is monospecific and restricted to the interior Pacific Northwest.

**B. Species Description**

Morphology: Pilsbry (1948) states "In the field this inconspicuous slug might be mistaken for *Deroceras*, having a tripartite sole and postmedian pneumostome . . . , but it differs by the weakly carinate back" (p. 732). The species is black to dark brown (deep grayish olive) on the mantle and back; the sole is cream-white. The reticulation on the posterior half of the body (tail) is indistinct, predominately with longitudinal lines above and oblique on the sides. The back of the mantle is keeled, the tail strongly so. The oval mantle somewhat exceeds about one-third the length of the body; the pneumostome is present in the posterior half of the mantle margin. The foot-margin is rather narrow. There is no caudal pore, but the tail appears somewhat abruptly truncate in profile. The shell is completely buried in the mantle. Body lengths of two animals from Idaho were 1.4 cm (mantle length 5.5 mm) and 2.3 cm (Pilsbry 1948). Internal anatomy is described and illustrated in Pilsbry (1948).

Reproductive biology: Hermaphroditic, based on internal anatomy (Pilsbry 1948). There is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown.

Ecology: Habitat descriptions are limited. Most occurrences in Idaho are in moist microsites in relatively intact *Pseudotsuga menziesii*, *Pinus ponderosa*, and *Picea engelmannii* forests (Frest and Johannes 1995) in moist valleys, ravines, and talus on both north- and south-facing slopes. Pilsbry (1948) lists collections made in meadows and cedar swamps, white pine stands, spruce valleys, rockslides, and near springs. *Populus* and *Alnus* present at several north Idaho locations (H. Reise personal communication). Rocky substrates include sedimentary, igneous and metamorphic types; the Prospect Creek, Sanders County, Montana site (Appendix B) is described as composed of calcareous shales (Pilsbry 1948). Herbivorous; food includes the epiphytic cryptogam *Frullania* (Pilsbry 1948).

### C. Range and Known Sites

*Zacoleus idahoensis* has so far been documented only in northern Idaho and northwestern Montana. In Montana, records exist for four widely separated sites in four counties: Granite, Lake, Lincoln, and Sanders (Fig. 11, Appendix B). Three of the localities (Kootenai Falls, Wild Horse Island, Squaw Rock Campground) were discovered during surveys of mollusks on bighorn sheep ranges (Forrester 1960, 1962); specific collection sites provided by Forrester (1960, 1962) are somewhat vague. The Prospect Creek site in Sanders County was the only one known in Montana at the time of publication of Pilsbry's monograph (Pilsbry 1948). Reported elevations of sites in Idaho range between 488-1707 m (1600-5600 ft) (Pilsbry 1948, H. Reise personal communication), the Montana sites range between 640-1494 m (2100-4900 ft).

### D. Species Abundance

No information, although it appears to still be present at several sites in Idaho (Frest and Johannes 1995), including as recently as 2001 (H. Reise personal communication). Pilsbry (1948) stated it was often abundant. Montana sites have not been revisited in decades.

## Current Status

### A. Why Species is of Conservation Concern

The Sheathed Slug (*Zacoleus idahoensis*) is a Species of Concern in Montana because it is a regional endemic so far documented at only four sites in four counties, none of which has been revisited in recent decades. Population sizes and trends are unknown, but habitat loss has occurred throughout the historic range (Frest and Johannes 1995).

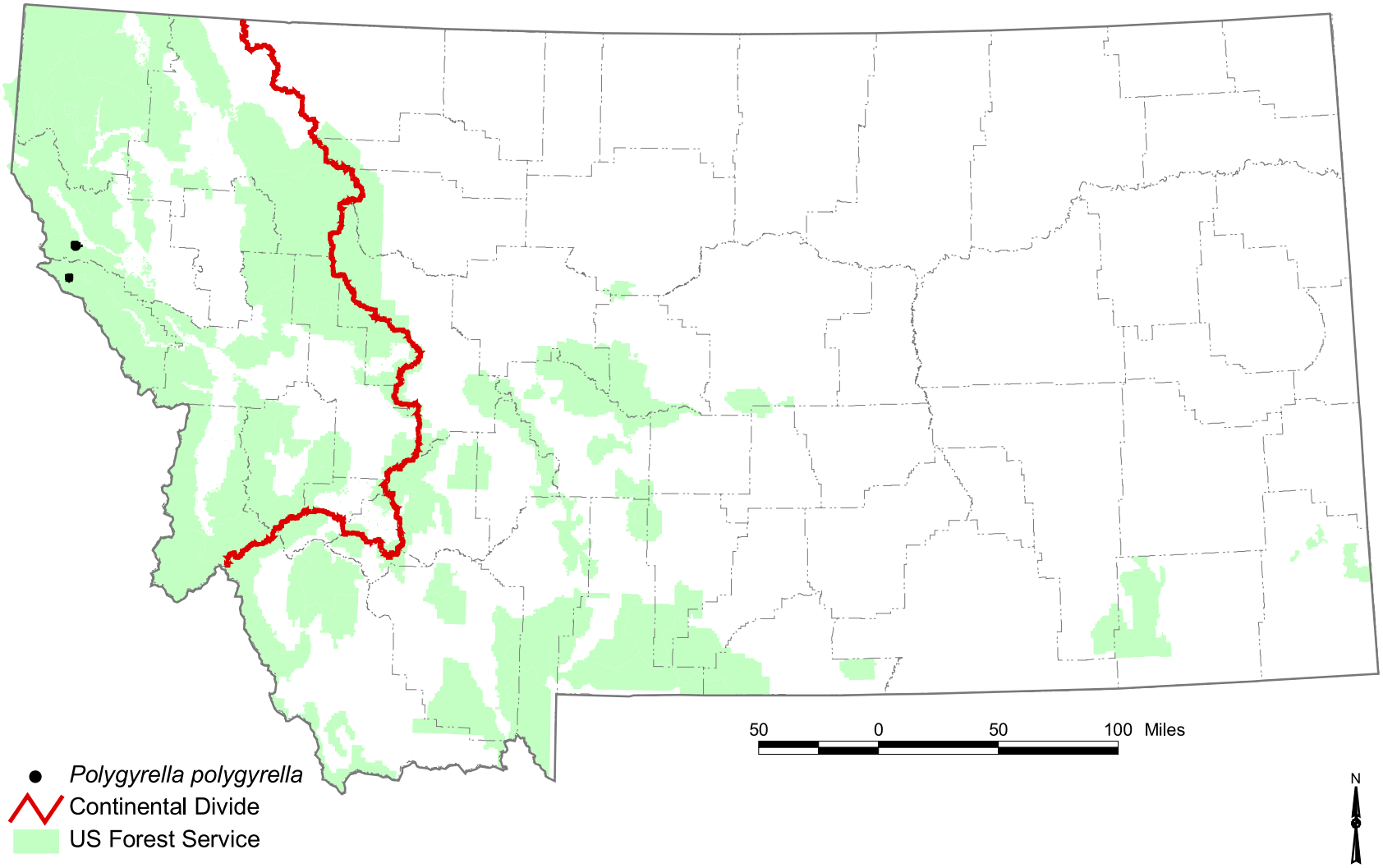
### B. Threats

Habitat occupied by *Zacoleus idahoensis* (moist sites in moderate elevation mixed conifer forest) is threatened by logging, grazing, fire, trail and highway expansion, possibly rural home development, and possibly recreation and weed control. The impact of fire retardant on this species and other terrestrial mollucks is unknown. Little is known about the biology of this species, including its sensitivity to disturbance.

### C. Distribution Relative to Land Allocations

Documented Montana sites are on lands administered by the Libby Ranger District, Kootenai National Forest (1 site), Thompson Falls Ranger District, Lolo National Forest with some private in-holdings (1 site), Philipsburg Ranger District, Beaverhead-Deerlodge National Forest (1 site), and State of Montana (1 site); the Beaverhead-Deerlodge site may be on Bureau of Land Management lands.

**Figure 12. Distribution of *Polygyrella polygyrella* in Montana.**



## SPECIES ON REVIEW

## SNAILS

**SPECIES:** *Polygyrella polygyrella* (Humped Coin)

**Heritage Rank**: GU, SU

**Natural History**

### A. Taxonomy

Family: Ammonitellidae
*Polygyrella polygyrella* (Bland and Cooper, 1861)

Originally described by Bland and Cooper (1861) as *Helix polygyrella*, with later placement by Cooper (1868) as *Helicodiscus polygyrella*. The genus is monospecific and restricted to interior Pacific Northwest.

### B. Species Description

Morphology: Pilsbry (1939) describes the shell as "discoidal, with wide umbilicus about one-third of the diameter; of a pale greenish yellow tint, somewhat translucent, glossy. Spire varies from nearly flat to convex, of very closely coiled whorls. Initial 2 to 3 whorls smooth, the rest with rather strong radial ribs which become obsolete near the aperture . . . Suture impressed, descending a little to the aperture. Umbilicus well-like, enlarging in the last half whorl. Aperture lunate-triangular, the peristome thickened within; parietal wall with an erect, triangular tooth connected with the ends of the lip. Within the last whorl there are one or two radial rows of three teeth each, visible through the shell" (p. 558-559). Shell diameter of 26 Idaho specimens ranged from 8.6 to 10.5 mm (mean = 9.7 mm), but diameter of specimens from other localities ranges to 13.0 mm. Number of whorls varies from 6.5 to 8.5. Shell height is from 40-50% of the diameter. Diameter of the type specimen, presumably from Sanders County, Montana, is 11.5 mm, height 5 mm (Bland and Cooper 1861). Internal anatomy is illustrated and described in Pilsbry (1939).

Reproductive biology: Hermaphroditic, based on internal anatomy (Pilsbry 1939). There is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown.

Ecology: Often found in moist forests of *Pseudotsuga menziezii* and *Picea engelmannii*, often in association with outcrops and talus of various rock types (Bland and Cooper 1861, Pilsbry 1939, Frest and Johannes 1995). Inhabits moss and decaying wood in dampest areas of forest cover (Bland and Cooper 1861, Cooper 1868); moist valley, ravine, and talus sites are

preferred, apparently near water (Frest and Johannes 1995). There is no information on food habits. Associated mollusk species include the slugs *Zacoleus* and *Hemphillia*.

### C. Range and Known Sites

*Polygyrella polygyrella* is found in northwestern Montana, northern Idaho, and the Blue Mountains of extreme southeastern Washington and extreme northeastern Oregon (Pilsbry 1939, Frest and Johannes 1995). The eastern slope of the Coeur d'Alene Mountains, Sanders County, Montana is considered the type locality (Pilsbry 1939, Frest and Johannes 1995), although the original description (Bland and Cooper 1861) places the locality only as the eastern slope of the Coeur d'Alene Mountains (later identified as Montana by Cooper 1868), which led others to place the type locality in Idaho (Elrod 1902, Henderson 1936, Coan 1981). The type locality may actually be somewhere in Mineral County; Cooper traveled along the road constructed by Lt. John Mullen up the St. Regis River from its confluence with the Clark Fork River at St. Regis (Coan 1981), passing through Mullen Gulch. In Montana, this species is currently recognized from four sites at elevations between 792 and 1097 m (2600 and 3600 ft) in two counties: Sanders and Mineral (Fig. 12, Appendix B). However, Elrod (1902) and Pilsbry (1939) note an unique variety of *Polygyrella polygyrella*, named *montanensis*, found in the "Deer Lodge Valley" sometime prior to 1902 by Mr. Hemphill. The locality is not listed in Appendix B, but indicates that the species may also be present in Powell or Deer Lodge counties. Additional locations are possible. Requirements may be similar to *Radiodiscus abietum*, judging by the similarity in their distributions.

### D. Species Abundance

No information. A few Idaho populations were still extant in the early 1990's (Frest and Johannes 1995), but there is no indication that the species has been found in Montana, even at the known localities, in recent decades.

## Current Status

### A. Why Species is of Conservation Concern

The Humped Coin (*Polygyrella polygyrella*) is a Species on Review in Montana because it is a regional endemic of unknown status so far documented at only four (possibly five) sites in two Montana counties, despite several decades of collecting in the region by Dr. R. B. Brunson and his students. There is evidence of extirpations and population declines in other states (Frest and Johannes 1995). Population sizes and trends in Montana are unknown, and there is no evidence that the snail has been documented in Montana in recent decades.

### B. Threats

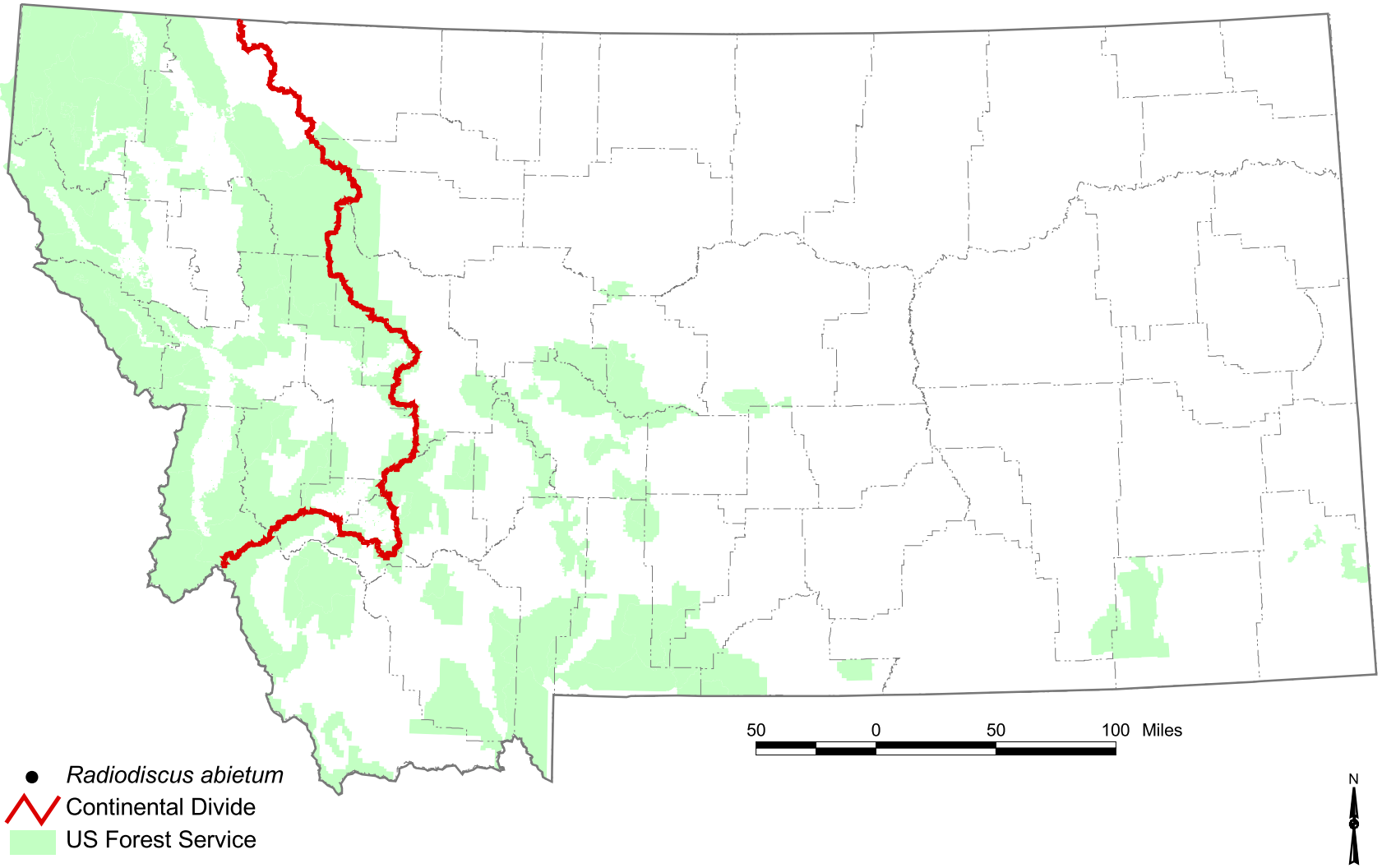
Logging and grazing over most of the known range are probably the greatest threats, through alteration of appropriate habitat. However, alteration of habitat from fire, highway and road

construction, rural home development and land clearing could represent threats, as could fire suppression retardants and chemical methods of weed control.

### C. Distribution Relative to Land Allocations

Documented Montana sites are on lands administered by the Thompson Falls Ranger District, Lolo National Forest with private in-holdings (1 site), Superior Ranger District, Lolo National Forest (1 possibly 2 sites), and 1 site on private land near Thompson Falls. The vague locality for the Deer Lodge Valley site precludes assigning ownership to the lands where it was found.

**Figure 13. Distribution of *Radiodiscus abietum* in Montana.**



**SPECIES:** *Radiodiscus abietum* (Fir Pinwheel)

**Heritage Rank**: GU, SU

**Natural History**

**A. Taxonomy**

Family: Helicodiscidae
*Radiodiscus abietum* Baker, 1930

The original designation and placement remain valid and unchanged (Pilsbry 1948, Frest and Johannes 1995).

**B. Species Description**

Morphology: Pilsbry (1948) describes the shell as "small (6.7 mm), subdiscoid, umbilicate, thin, but with heavy, almost opaque epidermis. Color: light chocolate-brown. Whorls: maximum 5 3/4, gradually increasing in diameter, well rounded but markedly flattened above; last slightly descending; suture deep. . . Sculpture of later whorls: growth-riblets quite low but angular and sharply defined, markedly and broadly concave below periphery . . . Umbilicus: about 6.1 times in maj. diam. of shell; with almost vertical walls. Aperture: crescentric, slightly oblique . . ." (p. 658, 660). Shell diameter is 4.9 to 6.7 mm, shell height 2.6 to 3.2 mm, with 5.0 to 5.75 whorls (Pilsbry 1948). Diameter of 15 "representative" shells from seven Montana localities ranged from 2.5 to 7.0 mm (mean = 5.1 mm); shell height ranged from 1.4 to 4.0 mm (mean = 2.8 mm); number of whorls ranged from 3.5 to 6.0 (Brunson and Russell 1967). Internal anatomy is illustrated and described in Pilsbry (1948).

Reproductive biology: Hermaphroditic, based on internal anatomy (Pilsbry 1948). There is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown, but Pilsbry (1948) indicated the type specimen (diameter 4.9 mm, 5 whorls) was immature.

Ecology: Surprisingly little detailed information is available. Most often found in moist and rocky Douglas-fir (*Pseudotsuga menziesii*) forest at mid-elevations in valleys and ravines (Frest and Johannes 1995). At some Montana locations, Western Red Cedar (*Thuja plicata*) formed the canopy. Often this species is found in or near talus of a variety of rock types or under fallen logs (Pilsbry 1948, Brunson and Russell 1967, Frest and Johannes 1995).

**C. Range and Known Sites**

*Radiodiscus abietum* is known from extreme northeastern Oregon, extreme northeastern and southeastern Washington, northern Idaho, and northwestern Montana (Pilsbry 1948, Frest and Johannes 1995). In Montana, this species has been found at 13 sites in six counties: Lake, Lincoln, Mineral, Missoula, Ravalli, and Sanders (Fig. 13, Appendix B). All sites are west of

the Continental Divide (Brunson and Russell 1967) at elevations from 823 to 1707 m (2700-5600 ft). Requirements may be similar to *Polygyrella polygyrella*, judging by the similarity of their distributions.

### D. Species Abundance

No information. Usually only single individuals were collected at the Montana sites (Brunson and Russell 1967). Frest and Johannes (1995) consider *Radiodiscus abietum* a species that was once common and widespread that is now much more rare.

## Current Status

### A. Why Species is of Conservation Concern

The Fir Pinwheel (*Radiodiscus abietum*) is a Species on Review in Montana because it is a regional endemic of unknown status, so far documented at 13 sites in six Montana counties, despite several decades of collecting in the region by Dr. R. B. Brunson and his students. There is evidence of extirpations and population declines in other states (Frest and Johannes 1995). Population sizes and trends in Montana are unknown, and there is no evidence that the snail has been documented in Montana in recent decades.

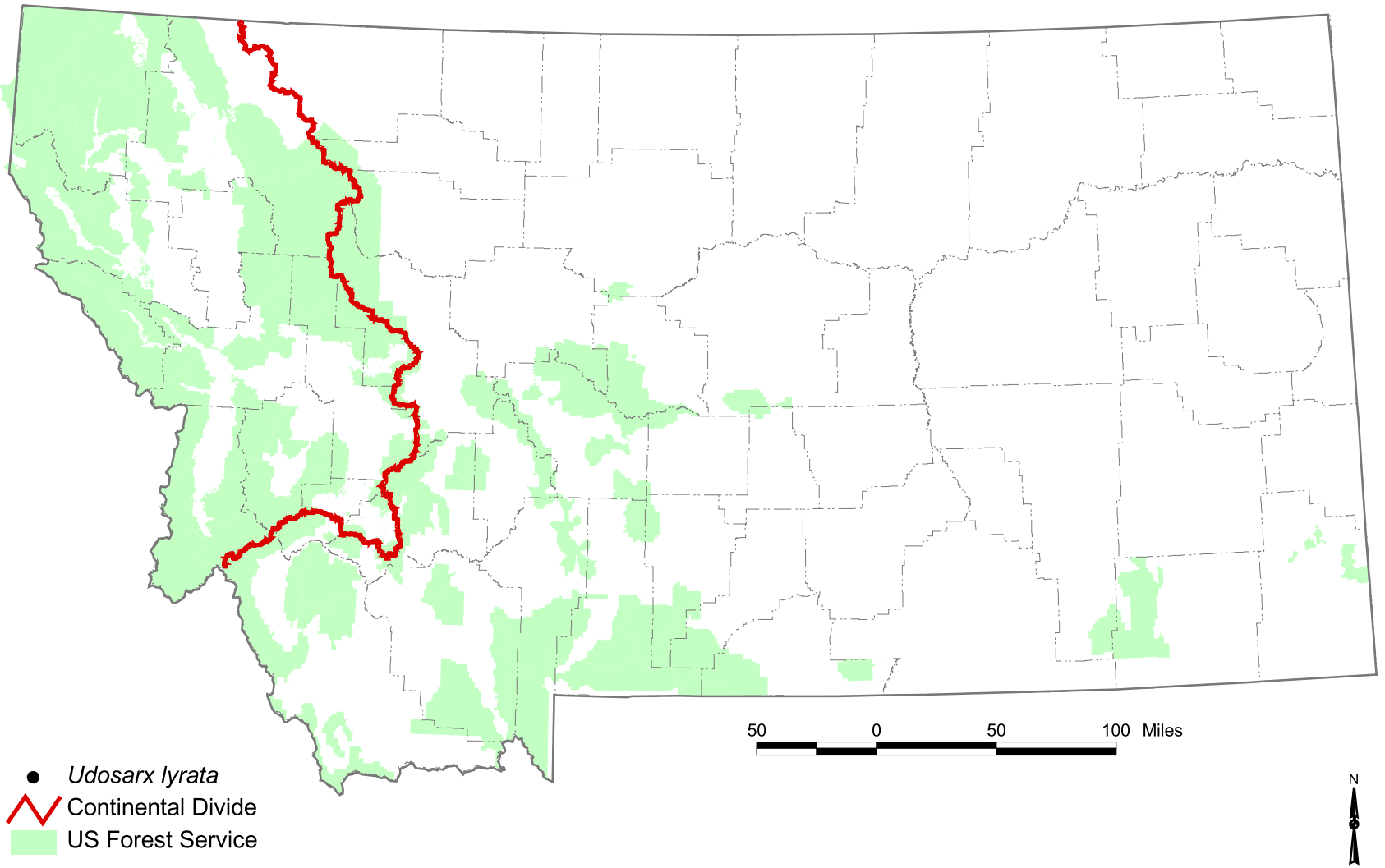
### B. Threats

Logging and grazing over most of the known range are probably the greatest threats, through alteration of appropriate habitat. However, alteration of habitat from fire, highway and road construction, rural home development and land clearing could represent threats, as could fire suppression retardants and chemical methods of weed control.

### C. Distribution Relative to Land Allocations

Documented Montana sites are on lands administered by the Confederated Salish and Kootenai Tribes (3 sites), State of Montana (1 site, but bounded closely by the Missoula Ranger District, Lolo National Forest), Superior Ranger District, Lolo National Forest (1 site), Darby Ranger District, Bitterroot National Forest (3 sites), Cabinet Ranger District, Kootenai National Forest (2 sites), Fisher River Ranger District, Kootenai National Forest (1 site), Libby Ranger District, Kootenai National Forest (1 site), and the Rexford Ranger District, Kootenai National Forest (1 site).

**Figure 14. Distribution of *Udosarx lyrata* in Montana.**



## SLUGS

**SPECIES:** *Udosarx lyrata* (Lyre Mantleslug)

**Heritage Rank**: G?TU, SU (*U. l. lyrata*);
G?T1, S1 (*U. l. russelli*)

**Natural History**

**A. Taxonomy**

Family: Arionidae
*Udosarx lyrata* Webb, 1959

The original species determination and name (Webb 1959) are still valid, although *Udosarx lyrata* is now included in the Arionidae instead of Webb's (1959) tentative placement in the Philomycidae and later placement (Russell and Webb 1980) with the Oreohelicidae. *Udosarx lyrata russelli* is a subspecies recognized by Russell and Webb (1980), however, they suggested that the subspecific designation might become useless once new material from additional localities is available for study. Because Webb's (1959) species description did not include a subspecies name, the original material was named *Udosarx lyrata lyrata* by Russell and Webb (1980). The genus is monospecific and restricted to the interior Pacific Northwest.

**B. Species Description**

Morphology: Webb (1959) notes that the external form of *Udosarx lyrata* is "much as in *Zacoleus*, mantle more elongate, back more carinate. Respiratory pore posterior, and posterior-edge of mantle notched (as in *Zacoleus*)" (p. 22). *Udosarx* differs from *Zacoleus* especially in the shape of the radular teeth. Webb (1959) continues that *Udosarx* is about half as large as sexually mature *Zacoleus.* The body is "bluish gray with a lighter tawny zone on the keel of the back. Grooves on the body darker than adjoining areas; 7-8 grooves from posterior mid-dorsum to posterior-edge of respiratory pore, much as in *Zacoleus*. Mantle with blackish lateral lines. Mid-mantle to front-edge with black punctuations vaguely delineating a grid pattern. Right line is more sinuous than the left, and the two lateral lines for a lyre-shaped symbol—hence the species name, *lyrata*. The intensity of coloration may vary" (p. 22).

An alcohol-preserved specimen of *Udosarx lyrata russelli* measured 2.4 cm in length (Russell and Webb 1980). For this subspecies, "the head and neck uniformly dark but not black. . . . The mantle is attached far back, so that the anteriorly a long free-lobe overlies the neck. The central area of the fore-half of the mantle bears a number (18-30) of scattered black dots and bars; unlike the holotype, the black lines of the upper sides extend forward to almost the front edge of the mantle. Otherwise the lines are as in the holotype, diverging from each other in very short arcs to give the lyre shape. The posterior mantle-edge is deeply notched . . . The respiratory pore is posterior and on the right edge of the mantle. The mantle covers somewhat

less than half the body, which is moderately carinate (not keeled) dorsally. The tail-tip is acutely pointed. . ." (p. 8). Internal anatomy is illustrated and described in Webb (1959) and Russell and Webb (1980); the latter publication also includes photographs of live animals that clearly show the lyre-pattern on the mantle.

Reproductive biology: Hermaphroditic, based on internal anatomy (Webb 1959, Russell and Webb 1980). Courtship and copulation were observed in captive animals in November (Russell and Webb 1980). Otherwise there is no description of reproductive behavior and its seasonal occurrence. Life span is unknown. Age/size at reproductive maturity is unknown, although presumably the individual 2.4 cm in body length (Russell and Webb 1980) was mature.

Ecology: Found in moist mixed-conifer subalpine forest, preferably in moist valleys, ravines, and talus sites (Webb 1959, Frest and Johannes 1995). Also found in riparian areas with a canopy of *Picea engelmannii*, *Pseudotsuga menziesii*, *Populus* and *Alnus* (W. Leonard personal communication). The subspecies *U. l. russelli* was found in south-facing open *Pinus ponderosa* forest with little undergrowth (Russell and Webb 1980). At all sites, individuals were located on the undersurfaces of fallen logs or within nearly completely rotten logs, and under rocks. Animals were active in wet and cold (10°C [50°F]) conditions (Webb 1959, Russell and Webb 1980); captive animals preferred temperatures <21°C (70°F).

**C. Range and Known Sites**

*Udosarx lyrata* has so far been documented only in northern Idaho and northwestern Montana (Frest and Johannes 1995). The type locality is near Lolo Pass, but on the Idaho side (Webb 1959). In Montana, records exist for only three sites in two counties: Missoula and Ravalli (Fig. 14, Appendix B). The two Missoula County sites, discovered in 1965 and 1966 near Potomac and Gold Creek (Russell and Webb 1980), are far from the Ravalli County site, discovered at Bunkhouse Creek in the Bitterroot Mountains in 2001 (W. Leonard personal communication). Reported elevations are 1067-1524 m (3500-5000 ft). Additional locations are likely to be discovered.

**D. Species Abundance**

Little information. Only one individual was found at the Ravalli County site (W. Leonard personal communication). Russell and Webb (1980) reported finding 17 individuals at the Potomac, Missoula County, site on 3 May 1965, several individuals on 21 November 1965, and 3 individuals on 5 May 1966. Two individuals were found at the Gold Creek, Missoula County, site on 5 May 1966. Russell (Russell and Webb 1980) collected an individual at the species type locality in 1966, almost 12 years after it was first found there (Webb 1959). Known to be present at some Idaho sites in recent years (Frest and Johannes 1995, W. Leonard personal communication).

## Current Status

### A. Why Species is of Conservation Concern

The Lyre Mantleslug (*Ususarx lyrata*) is a Species on Review in Montana because it is a regional endemic of unknown status so far documented at three sites in two Montana counties, despite several decades of collecting in the region by Dr. R. B. Brunson and his students. There is evidence of extirpations or population declines, largely inferred from loss of habitat (Frest and Johannes 1995). Population sizes and trends in Montana are unknown, and there is no evidence that the Missoula County sites have been resurveyed in recent decades.

### B. Threats

Habitat occupied by *Udosarx lyrata* (moist sites in valley and mid-elevation mixed conifer forest) is threatened by logging, grazing, fire, possibly rural home development and road construction, and possibly recreation and weed control. The impact of fire retardant and chemical means of weed control on this and other terrestrial mollusk species is unknown. Little is known about the biology of this species, including its sensitivity to disturbance.

### C. Distribution Relative to Land Allocations

Documented Montana sites are on lands administered by the Darby Ranger District, Bitterroot National Forest (1 site), Plum Creek Timber Company (1 site), and private ownership (1 site). The type locality in Idaho is 4 km (2.5 mi) from land in Montana administered by the Missoula Ranger District, Lolo National Forest and Plum Creek Timber Company.

## Bibliography of Montana Terrestrial Mollusks of Special Concern


Bartsch, P. 1916. Two new land shells from the western states. Proceedings of the United States National Museum 51:331-333.

Beetle, D. E. 1957. The mollusca of Teton County, Wyoming. The Nautilus 71:12-22.

Beetle, D. E. 1961. Mollusca of the Big Horn Mountains. The Nautilus 74:95-102.

Beetle, D. E. 1989. Checklist of recent mollusca of Wyoming, USA. Great Basin Naturalist 49:637-645.

Beetle, D. E. 1997. Recolonization of burned aspen groves by land snails. Yellowstone Science 5(summer):6-8.

Berry, S. S. 1913. A list of mollusca from the Musselshell Valley, Montana. The Nautilus 26:130-131.

Berry, S. S. 1916. Notes on mollusca of central Montana. The Nautilus 29:124-128.

Berry, S. S. 1919. Mollusca of Glacier National Park. Proceedings of the Academy of Natural Sciences of Philadelphia 71:195-205.

Berry, S. S. 1955. An important new land snail from the Mission Range, Montana. Bulletin of the Southern California Academy of Sciences 54:17-19.

Bland, T., and J. G. Cooper. 1861. Notice of land and freshwater shells collected by Dr. J. G. Cooper in the Rocky Mountains, etc., in 1860. Annals of the Lyceum of Natural History of New York 7:362-370.

Boag, D. A., and W. D. Wishart. 1982. Distribution and abundance of terrestrial gastropods on a winter range of bighorn sheep in southwestern Alberta. Canadian Journal of Zoology 60:2633-2640.

Brunson, R. B. 1956. The mystery of *Discus brunsoni*. The Nautilus 70:16-21.

Brunson, R. B., and N. Kevern. 1963. Observations of a colony of *Magnipelta*. The Nautilus 77:23-27.

Brunson, R. B., and U. Osher. 1957. *Haplotrema* from western Montana. The Nautilus 70:121-123.

Brunson, R. B., and R. H. Russell. 1967. *Radiodiscus*, new to molluscan fauna of Montana. The Nautilus 81:18-22.

Carlson, J. 2003. Montana Animal Species of Concern. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks, Helena, Montana. 14 pp.

Coan, E. 1981. James Graham Cooper, pioneer western naturalist. University Press of Idaho, Moscow, ID. 255 pp.

Cooper, J. G. 1868. The shells of Montana. American Naturalist 2:486-487.

Elrod, M. J. 1901a. Montana shells. Rocky Mountain Magazine 2:691-697.

Elrod, M. J. 1901b. Limnological investigations at Flathead Lake, Montana, and vicinity, July, 1899. Transactions of the American Microscopical Society 22:63-80.

Elrod, M. J. 1901-1902. Collecting shells in Montana. The Nautilus 15:86-89, 103-104, 110-112, 129-130.

Elrod, M. J. 1902. A biological reconnoissance in the vicinity of Flathead Lake. University of Montana Bulletin No. 10, Biological Series No. 3.

Elrod, M. J. 1903a. Notes on *Pyramidula elrodi* Pils. The Nautilus 16:109-112.

Elrod, M. J. 1903b. Montana shells-*Pyramidula strigosa*. The Nautilus 17:1-6.

Fairbanks, H. L. 1980. Morphological notes on *Oreohelix amariradix* Pilsbry, 1934 (Pulmonata: Oreohelicidae). The Nautilus 94:27-30.

Fairbanks, H. L. 1984. A new species of *Oreohelix* (Gastropoda: Pulmonata: Oreohelicidae) from the Seven Devils Mountains, Idaho. Proceedings of the Biological Society of Washington 97:179-185.

Fairbanks, H. L. 2002. The reproductive anatomy, taxonomic status, and range of *Oreohelix alpina* (Elrod, 1901) (Gastropoda: Pulmonata: Oreohelicidae). The Nautilus 116:in press.

Forrester, D. J. 1960. A preliminary investigation of the protostrongylin lungworm-bighorn sheep relationships in Montana. M.S. thesis, Montana State University, Missoula. 79 pp.

Forrester, D. J. 1962. Land mollusca as possible intermediate hosts of *Protostrongylus stilesi*, a lungworm of bighorn sheep in western Montana. Proceedings of the Montana Academy of Sciences 22:82-92.

Frest, T. J., and E. J. Johannes. 1993. Land snail survey of the Black Hills National Forest, South Dakota and Wyoming. Final report to USDA Forest Service, Black Hills National Forest and USDI Fish & Wildlife Service, South Dakota State Office. 156 pp. + appendices.

Frest, T. J., and E. J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern. Final Report to Interior Columbia Basin Ecosystem Management Project. Deixis Consultants,

Seattle. 274 pp.
Henderson, J. 1924. Mollusca of Colorado, Utah, Montana, Idaho, and Wyoming. The University of Colorado Studies 13:65-223.

Henderson, J. 1933. Mollusca of the Yellowstone Park, Teton Park and Jackson Hole region. The Nautilus 47:1-3.

Henderson, J. 1936. Mollusca of Colorado, Utah, Montana, Idaho, and Wyoming-supplement. The University of Colorado Studies 23:81-145.

Hendricks, P. 1998. Rediscovery of *Discus brunsoni* Berry, 1955 and *Oreohelix alpina* (Elrod, 1901) in the Mission Mountains, Montana, with comments on *Oreohelix elrodi* (Pilsbry, 1900). The Nautilus 112:58-62.

Karlin, E. J. 1961. Ecological relationships between vegetation and the distribution of land snails in Montana, Colorado and New Mexico. American Midland Naturalist 65:60-66.

Leonard, W. P., and K. Ovaska. 2002. Reproduction of the Malone jumping-slug, *Hemphillia malonei* Pilsbry, 1917 (Mollusca: Gastropoda: Arionidae): laboratory observations. Nemouria 45:1-15.

Niwa, C. G., R. E. Sandquist, R Crawford, and 18 others. 2001. Invertebrates of the Columbia River basin assessment area. Gen. Tech. Rep. PNW-GTR-512. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 74 pp.

Ovaska, K., L. Chichester, H. Reise, W. P. Leonard, and J. Baugh. 2002. Anatomy of the dromedary jumping-slug, *Hemphillia dromedarius* Branson, 1972 (Gastropoda: Stylommatophora: Arionidae), with new distributional records. The Nautilus 116:89-94.

Pilsbry, H. A. 1900. Notices of new American snails. The Nautilus 14:40-41

Pilsbry, H. A. 1912. Two new American land shells collected by Messrs. Hebard and Rehn. The Nautilus 26:88-90.

Pilsbry, H. A. 1933. Notes on the anatomy of Oreohelix,—III, with descriptions of new species and subspecies. Proceedings of the Academy of Natural Sciences of Philadelphia 85:383-410.

Pilsbry, H. A. 1939. Land mollusca of North America (north of Mexico), Volume I Part 1. The Academy of Natural Sciences of Philadelphia Monographs Number 3 (1):1-573.

Pilsbry, H. A. 1948. Land mollusca of North America (north of Mexico), Volume II Part 2. The Academy of Natural Sciences of Philadelphia Monographs Number 3 (2):521-1113.

Pilsbry, H. A. 1953. *Magnipelta*, a new genus of Arionidae from Idaho. The Nautilus 67:37-38.

Pilsbry, H. A., and R. B. Brunson. 1954. The Idaho-Montana slug *Magnipelta* (Arionidae). Notulae Naturae 262:1-6.

Platt, T. R. 1980. Observations on the terrestrial gastropods in the vicinity of Jasper, Alberta (Canada). The Nautilus 94:18-21.

Russell, R. H., and R. B. Brunson. 1967. A check-list of molluscs of Glacier National Park, Montana. Sterkiana 26:1-5.

Russell, R. H., and G. R. Webb. 1980. The slug *Udosarx lyrata*: additional data on distribution, anatomy, and taxonomy. Gastropodia 2:8-10.

Squyer, H. 1894. List of shells from the vicinity of Mingusville, Montana. The Nautilus 8:63-65.

Vanatta, E. G. 1914. Montana shells. Proceedings of the Academy of Natural Sciences of Philadelphia 66:367-371.

Webb, G. R. 1959. Two new north-western slugs, *Udosarx lyrata* and *Gliabates oregonia*. Gastropodia 1(3):22-23, 28.

Webb, G. R., and R. H. Russell. 1977. Anatomical notes on a *Magnipelta*: Camaenidae? Gastropodia 1(10):107-108.

# APPENDIX A. GLOBAL/STATE RANK DEFINITIONS

**Heritage Program Ranks**

The international network of Natural Heritage Programs employs a standardized ranking system to denote global (range-wide) and state status (NatureServe 2002). Species are assigned numeric ranks ranging from 1 (critically imperiled) to 5 (demonstrably secure), reflecting the relative degree to which they are "at-risk". Rank definitions are given below. A number of factors are considered in assigning ranks — the number, size and distribution of known "occurrences" or populations, population trends (if known), habitat sensitivity, and threat. Factors in a species' life history that make it especially vulnerable are also considered (e.g., dependence on a specific pollinator).

**Rank Definitions**

| | |
|---|---|
| G1 S1 | Critically imperiled because of extreme rarity and/or other factors making it highly vulnerable to extinction. |
| G2 S2 | Imperiled because of rarity and/or other factors making it vulnerable to extinction. |
| G3 S3 | Vulnerable because of rarity or restricted range and/or other factors, even though it may be abundant at some of its locations. |
| G4 S4 | Apparently secure, though it may be quite rare in parts of its range, especially at the periphery. |
| G5 S5 | Demonstrably secure, though it may be quite rare in parts of its range, especially at the periphery. |
| GU SU | Possibly imperiled, but status uncertain; more information needed. |
| GA SA | Native in nearby states, but in Montana believed to be accidentally introduced, deliberately planted, or escaped from plantings. |
| GH SH | Historical, known only from records over 50 year ago; may be rediscovered. |
| GX SX | Believed to be extinct; historical records only. |

**Combination Ranks**

G#G# or S#S# Indicates a range of uncertainty about the rarity of the species.

**Subranks**

| | |
|---|---|
| T# | Rank of a subspecies or variety; appended to the species' global rank of the full species, e.g. G4T3. |

**Qualifiers**

| | |
|---|---|
| Q | Taxonomic questions or problems exist, more information needed; appended to the global rank, e.g. G3Q. |
| ? | Denotes uncertainty or for numeric ranks, inexactness. |

# APPENDIX B. LOCALITY AND COLLECTION RECORDS FOR 15 TERRESTRIAL MOLLUSK TAXA OF CONSERVATION CONCERN IN MONTANA

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Discus brunsoni* | McDonald Lake, Mission Mtns | T19N,R19W, sec 11NE | 3700 | Lake | 26 Aug. 1948; 23 June 1950; 1 June 1954; 4 May, 2 July 1955; 16 May 1957; 27 April 1960; 16 and 29 May 1964; 1 and 10 July 1997 | diorite talus, TYPE LOCALITY | Berry 1955, Brunson 1956, Hendricks 1998; CAS #IZ64413; FMNH #'s 98033, 108561; USNM # 673345 (paratype); Hendricks specimens |
| *Discus shimeki* | W of Nurses Lakes | T3S,R12E, sec 30SWNE | 6360 | Park | 2 August, 2000 | aspen stand | Hendricks record |
| *Discus shimeki* | Beaver Creek, Bears Paw Mtns | T28N,R16E, sec 3NWNE | 4240 | Hill | 20 June, 1997 | aspen stand | Hendricks record |
| *Discus shimeki* | falls of Natural Bridge, Boulder River, Absaroka Mtns. | T3S,R12E, sec 26NW | 5100 | Sweetgrass | ?? | limestone, with Doug-fir cover | Pilsbry 1948 |
| *Discus shimeki* | E of Kootenai Falls | T31N,R32W, sec 15 | 2100 | Lincoln | 17 Sept., 1959 | | Forrester 1960; FMNH #108487: Kootenai Falls sheep range |
| *Discus shimeki* | Gallatin River corridor | T6S,R4E, sec 22 | 6000 | Gallatin | 23 April, 1960 | | Forrester 1960; USNM #762513; Clyde Senger specimen, FMNH #108538: Gallatin sheep range |
| *Hemphillia danielsi* | Bunkhouse Creek, Bitterroot Mtns | T3N,R21W, sec 7 middle | 5000 | Ravalli | 26 July, 2001 | riparian spruce, Doug-fir, cottonwood, alder | Bill Leonard record; photo |
| *Hemphillia danielsi* | Camas Creek, Bitteroot Mtns | T5N,R21W, sec 33SW | ca. 4800? | Ravalli | 12 May 1912; 7 October 2001 | riparian mixed conifer/deciduous, TYPE LOCALITY | Pilsbry 1948; ANSP# 110052 (holotype); Heike Reise record |
| *Hemphillia danielsi* | Mill Creek, Bitterroot Mtns | T6N,R22W, sec 1NENE | 4950 | Ravalli | 20 Oct., 2001 | streamside, under cobble | B. Maxell record; Hendricks specimen |
| *Hemphillia danielsi* | Medicine Hot Springs, Bitterroot Mtns | T1N,R20W, sec 12SW | 4400 | Ravalli | 1912 | | Pilsbry 1948 |

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Hemphillia danielsi* | N end Ward Mtn, Bitterroot Mtns | T5N,R21W, sec 17NW? | 4825 | Ravalli | 21 April, 1912 | | Pilsbry 1948; ANSP # 110053 |
| *Magnipelta mycophaga* | Thompson River bottom, 3 mi S of Bend | T24N,R27W, sec 12NWNE | 3140 | Sanders | 16 May, 2001 | shrubby willow/dogwood, Ribes, snowberry; scattered ponderosa pine and Douglas-fir nearby | Hendricks record; photo |
| *Magnipelta mycophaga* | Little Park Creek, Sapphire Mtns | T12N,R18W, sec 30NESW | 4300 | Missoula | 24 May 1998; 26 Sept. 2000 | riparian alder, spruce, subalpine fir | Hendricks record; photo |
| *Magnipelta mycophaga* | Marten Creek | T25N,R33W, sec 25SESE | 2500 | Sanders | 7 May, 1999 | grand fir, alder | Hendricks record; photo |
| *Magnipelta mycophaga* | Deer Creek, Sapphire Mtns | T12N,R18W, sec 7NENW | 4100 | Missoula | 26 May and 14 June 1954; 29 April-23 Sept. 1957 | Doug-fir, spruce, subalpine fir, western larch, ponderosa pine | Pilsbry and Brunson 1954, Brunson and Kevern 1963; FMNH #108562 |
| *Magnipelta mycophaga* | Red Meadow Lake | T35N,R23W, sec 34NW | ca. 5200 | Flathead | 31 July, 1951 | subalpine fir-whitebark pine | Pilsbry and Brunson 1954; Brunson catalog #M6151 |
| *Magnipelta mycophaga* | centered on McGuire Creek | T34N,R29W, sec 24 | 3500? | Lincoln | 1959? | | Forrester 1960,1962: centered on Ural-Tweed sheep range, Inch and McGuire Mtns. |
| *Oreohelix alpina* | above Lower Rumble Lake, Swan Mtns | T21N,R16W, sec 36SESW | 7200 | Missoula | 10 Aug. 1975; 11 Sept. 2000 | limestone talus | Fairbanks 2002; Hammer and Fairbanks specimens; Hendricks specimens |
| *Oreohelix alpina* | E. St Marys Pk, Mission Mtns | T18N,R18W, sec 21SW | 8900-9400 | Lake | 15 July 1900; 27 Aug. 1997 | alpine limestone talus: TYPE LOCALITY | Elrod 1902, 1903b; Hendricks 1998; FMNH #108485 |
| *Oreohelix alpina* | West McDonald Peak, Mission Mtns. | T19N,R19W, sec 24SE | 7400-8000 | Lake | 22 July, 1900 | limestone talus, west ridge crest | Elrod 1902, 1903b |
| *Oreohelix alpina* | McDonald Peak, 120 ft below summit on S ridge | T19N,R18W, sec 29NWNE | 9700 | Lake | 18 Sept., 1952 | limestone talus | J. Chapman specimen, FMNH #108486 |

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Oreohelix alpina* | McDonald Peak; above Duncan Lake | T19N,R18W, sec 30NE | 8500 | Lake | 2 Aug., 1949 | limestone talus | Brunson catalog #M31349 |
| *Oreohelix amariradix* | 4.5-4.6 mi W of Lolo along US 12 | T12N,R21W, sec 36SWSE | 3500 | Missoula | 20 July 1902; 9 July 1950; 23 and 30 May 1976; 29 May 1977; March 1978 | small talus slides on N slope opposite Ft. Fizzle; in ponderosa pine, serviceberry, ninebark, bunch grasses. TYPE LOCALITY | Fairbanks 1980; ANSP # 78740 (holotype), 345588, 347820; FMNH # 74757, 84740 |
| *Oreohelix amariradix* | near Lolo Creek, across from other location | T12N,R21W, sec 36SWNE | 3500 | Missoula | 5 June, 1976 | talus slope (in ponderosa pine?) | Fairbanks record |
| *Oreohelix carinifera* | old Byrne Resort, Nimrod Hot Springs | T11N,R15W, sec 14SESW | 4100 | Granite | 13 July, 1975 | small rock outcrops above pond | Fairbanks record |
| *Oreohelix carinifera* | Grouse Creek | T11N,R15W, sec 35/36S | 4300? | Granite | 15 Nov., 1975 | sandy limestone, S facing slopes w/juniper and Doug-fir | Fairbanks record |
| *Oreohelix carinifera* | Wet Mulkey Gulch | T12N,R13W, sec 32SENW | 4850 | Granite | 3 Aug. 2002 | sandy limestone, S facing slope, open Doug. Fir canopy with common juniper in understory | Hendricks specimens (MTHP 4293); dead shells |
| *Oreohelix carinifera* | Garrison Jct. | T9N,R10W, sec14SofSE, sec 23NofNE | 4300 | Powell | 1907; 1909; 4 Sept. 1931; 25 Aug. 1934; 7 July 1947; 28 April 1960; 17 July 1976; 28 May 1977 | S facing limestone slope, on surface of outcrop and among junipers: TYPE LOCALITY | ANSP #'s 99253 (paratypes), 345537, A14840; FMNH #'s 84747, 97987, 98161, 111794 |
| *Oreohelix elrodi* | Goat Creek, Swan Mtns | T23N,R17W, sec 12NENW | 4250 | Lake | 9 June, 1999 | argillite talus | Hendricks specimens |
| *Oreohelix elrodi* | Lion Creek, Swan Mtns | T22N,R17W, sec 11SW-13NE | 3600-4000 | Lake | ca. 1975; 25 Sept. 1997; 19 May 1999 | argillite talus | Fairbanks 1984; Hendricks specimens |

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Oreohelix elrodi* | McDonald Lake, Mission Mtns | T19N,R19W, sec 11NE | 3700 | Lake | July 1899; July 1900; June 1901; 1902; 16 May, 7 and 17 July, 7 Aug. 1947; 26 Aug. 1948; 7 Sept. 1950; 2 Oct. 1955; 29 June 1956; 11 May 1959; 27 April 1960; 10 June, 1 July 1997 | argillite and diorite talus: TYPE LOCALITY | Elrod 1902, 1903a, Pilsbry 1939, Hendricks 1998; ANSP #'s 78740 (lectotype), 348135, 346218, 345811; FMNH #'s 40079, 40080, 60312, 74395, 74754, 86584, 90351, 90352, 90492, 90527, 97864, 98120, 117891, 146468, 172603; USNM # 160833 |
| *Oreohelix strigosa berryi* | 1 mi E Piper | T14N,R20E, sec 9SE | 4500 | Fergus | 12 Sept., 1944 | SW facing slope, under creeping juniper | USNM # 592753 |
| *Oreohelix strigosa berryi* | "vicinity of Montanapolis" | T6S,R10E, sec 19 | 6200 | Park | 1994 | | Frest and Johannes 1995 |
| *Oreohelix strigosa berryi* | 7 mi S Lewistown, near Big Spring | T14N,R19E, sec 5SE | 4250 | Fergus | 13 Sept., 1944 | S facing slope | USNM # 592752 |
| *Oreohelix strigosa berryi* | Half Moon Pass, Big Snowy Mtns. | T12N,R19E, sec 28SW | 7300 | Fergus | ?? | | USNM # 477463 |
| *Oreohelix strigosa berryi* | Dry Pole Canyon, Big Snowy Mtns. | T12N,R17E | 5500-6500 | Fergus | ?? | | USNM # 477391 |
| *Oreohelix strigosa berryi* | Swimming Woman Canyon, Big Snowy Mtns., about half a mile above the mouth | T11N,R19E, sec 16NW | 5880 | Golden Valley | 4 July, 1914 | TYPE LOCALITY | see Pilsbry 1933 for location |
| *Oreohelix strigosa berryi* | Blake Creek Canyon, Big Snowy Mtns. | T11N,R18E | | Fergus | 14 Sept., 1919 | | |
| *Oreohelix strigosa berryi* | Judith Mtns. | T16N,R19E, sec 16SENE | 5320 | Fergus | 20 April, 1998 | rocky slope of limestone in old burn | Hendricks specimens: ID not confirmed, but likely |

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Oreohelix strigosa berryi* | Timber Creek Canyon, Big Snowy Mtns. | T11N,R18E | | Fergus | ?? | | Berry specimen |
| *Oreohelix strigosa berryi* | W of head, Middle Cottonwood Canyon, Big Snowy Mtns. | T12N,R18E, sec 26? | ca. 8000 | Fergus | ?? | | Berry specimen |
| *Oreohelix yavapai mariae* | 1/4 mi from mouth of Squaw Creek, and also N side of canyon | T4S,R4E, sec 34SWSW | 5600 | Gallatin | prior to 1916; 30 Aug. 1925; 30 Aug. 1939; 8 July 1947; 4 May 1976 | S-facing open grassy slope at base of outcrop: TYPE LOCALITY | Bartsch 1916; USNM # 522585, 215132 (types and paratypes); ANSP #345575, 113374 (paratype) |
| *Polygyrella polygyrella* | 3-6 mi up Prospect Creek W of Thompson Falls, Coeur d'Alene Mtns. | T21N,R30W, sec 21-23 | 2800 | Sanders | ??(prior to 1936) | moss and decaying wood in dampest parts of spruce forest | Henderson 1936, Baker record in Pilsbry 1939 |
| *Polygyrella polygyrella* | 2 mi. W Thompson Falls at confluence of Clear Cr. With Prospect Cr. | T21N,R30W,sec. 13NESW | 2600 | Sanders | 1 May, 1949 | | Brunson catalog #M10049 |
| *Polygyrella polygyrella* | West Fork Big Creek, DeBorgia | T19N,R30W,sec .30SE? | 3600? | Mineral | 17 May, 1964 | | Brunson catalog #M2964, M3364: TRS not given |
| *Polygyrella polygyrella* | E slope of Coeur d' Alene Mtns. | ?? (? SW of DeBorgia; possibly Dry Cr., or NW of St. Regis in Mullen Gulch?) | ?? | ? Sanders or Mineral ? | Sept., 1860 | in moss and decaying wood in damp spruce forest: TYPE LOCALITY | Bland and Cooper 1861; Coan 1981 gives type locality as in ID, but Pilsbry 1939 lists Sanders Co., MT: Cooper 1868 gives MT |
| *Prophysaon humile* | Yellow Bay Biol. Stn. | T24N,R19W, sec. 4NE | ca. 3000 | Lake | 11 July. 1960 | | FMNH #119010 |
| *Radiodiscus abietum* | between Leigh Lake trail and Leigh Creek, Cabinet Mtns. | T28N,R31W,sec .6NWNE | 3900 | Lincoln | 27 July, 1960 | under log | Brunson and Russell 1967 |

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Radiodiscus abietum* | 4 mi. W Noxon | T26N,R33W,sec .17SESE | 3000 | Sanders | 2 May, 1965 | | Brunson and Russell 1967 |
| *Radiodiscus abietum* | Government Creek at Noxon, Cabinet Mtns. | T26N,R32W,sec .20NW | 2700 | Sanders | 20 June, 1956 | | Brunson and Russell 1967; Brunson catalog gives 26 June |
| *Radiodiscus abietum* | South Crow Cirque, W end of Schwartz Lk., Mission Mtns. | T20N,R19W,sec . 10SESE | 3950 | Lake | 7 July, 1960 | | Brunson and Russell 1967; FMNH #105851 |
| *Radiodiscus abietum* | McDonald Lake at dam, Mission Mtns | T19N,R19W,sec .10NENE | 3600 | Lake | 19 June, 1960 | | FMNH #110641 |
| *Radiodiscus abietum* | McDonald Cirque above McDonald Lake, Mission Mtns. | T19N,R19W,sec . 11NW | 3600 | Lake | 11 May 1959, 17 and 23 June 1960, 16 May 1964 | wet bank W side of talus slide | Brunson and Russell 1967; elev must be in sec. 11, not sec. 2 as given for 1960 record; 1959 and 1964 records not published (Brunson catalog #M1259 and M664) |
| *Radiodiscus abietum* | Crystal Lake Trail, ca. 5 mi. S DeBorgia | T18N,R30W,sec .15SW | 4000 | Mineral | 17 Oct., 1965 | under fallen logs in cedar forest | Brunson and Russell 1967; elev given as 2800' with no TRS but trail starts higher up |
| *Radiodiscus abietum* | Deep Creek, Bitterroot Mtns. | T13N,R21W,sec . 20NW | 4000 | Missoula | 11 May, 1957 | | Brunson and Russell 1967 |
| *Radiodiscus abietum* | N. Fork Lost Horse Cr., Bitterroot Mtns. | T5N,R22W,sec. 35SWSE | 5600 | Ravalli | May, 1960 | | Brunson and Russell 1967 |
| *Radiodiscus abietum* | Lost Horse Creek, Bitterroot Mtns. | T4N,R22W,sec. 6NWNW | 5000 | Ravalli | 5 June, 1960 | | Brunson and Russell 1967 |

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Radiodiscus abietum* | Sleeping Child Cr. below Sleeping Child Hot Springs, Sapphire Mtns. | T4N,R19W,sec. 7NW | 4550 | Ravalli | 31 December, 1965 | | Brunson and Russell 1967 |
| *Radiodiscus abietum* | SW shoulder Stenerson Mtn. | T32N,R28W,sec. 3 | ca. 5000 | Lincoln | 15 Sept., 1959 | | Forrester specimen in FMNH #108508: Ural-Tweed sheep range |
| *Radiodiscus abietum* | Tweed Creek | T34N,R29W,sec. 35 | ca. 4000 | Lincoln | 18 July, 1962 | | FMNH #117379; Ural-Tweed sheep range |
| *Udosarx lyrata* | Bunkhouse Creek, Bitterroot Mtns | T3N,R21W, sec 7 middle | 5000 | Ravalli | 26 July, 2001 | riparian spruce, Doug-fir, cottonwood, alder | Bill Leonard record; photo |
| *Udosarx lyrata* | ca. 2 mi. N Twin Creeks Lumber Camp, near wetland and F.S. road | T14N,R17W,sec 25SW | 4000 | Missoula | 5 May, 1966 | under rocks near spring-fed 0.5 acre pond; open coniferous ponderosa pine and Douglas-fir | Russell and Webb 1980; in Dick Russell unpublished notes and correspondance |
| *Udosarx lyrata russelli* | 1 mi W of Potomac | T13N,R16W, sec 10 (possibly sec 15) | 3500 | Missoula | 3 May and 21 Nov. 1965, 5 May 1966 | S slope above Union Creek, under logs; ponderosa pine and undergrowth: TYPE LOCALITY for subspecies | Russell and Webb 1980; ANSP# 358248 |
| *Zacoleus idahoensis* | E of Kootenai Falls, Purcell Mtns. | T31N,R32W, sec 15 | 2100 | Lincoln | 1959? | | Forrester 1960, 1962: Kootenai Falls sheep range |
| *Zacoleus idahoensis* | centered on Squaw Rock CG, Sapphire Mtns. | T7N,R16W, sec 21 | 4900 | Granite | 1959? | | Forrester 1960, 1962: Rock Creek sheep range |
| *Zacoleus idahoensis* | 3-6 mi up Prospect Creek W of Thompson Falls, Coeur d'Alene Mtns. | T21N,R30W, sec 21-23 | 2800 | Sanders | ?? | | Baker record in Pilsbry 1939 |

| Species | Location | TRS | Elev (ft) | County | Date | Habitat | Notes[a] |
|---|---|---|---|---|---|---|---|
| *Zacoleus idahoensis* | centered on landing site at Wild Horse Island, Flathead Lake | T24N,R20W, sec 13 | 2900 | Lake | 1959? | under driftwood near shoreline | Forrester 1960: Wild Horse sheep range |

[a] ANSP (Academy of Natural Sciences, Philadelphia), CAS (California Academy of Sciences), FMNH (Field Museum of Natural History, Chicago), USNM (U. S. National Museum).

# APPENDIX C. GUIDELINES FOR DESIGNING AND CONDUCTING SURVEYS OF TERRESTRIAL MOLLUSKS

## Survey Guidelines for Terrestrial Mollusks

The design of surveys for terrestrial mollusks is fairly simple if the objective is to look specifically for selected target species. In addition to determining presence-absence, some additional habitat information can be collected relatively quickly that will add significantly to the extremely limited body of knowledge on the ecology of most species of conservation concern in Montana. With this in mind, the few suggestions that follow on survey methods should provide biologists unfamiliar with terrestrial mollusks the rudiments needed to determine presence-absence, relative abundance, and habitat associations of any of the species discussed in the species accounts of this report. Remember that with experience comes familiarity. I have also included a short list of references where some of the techniques are discussed in more detail and applied to particular field situations. Frest and Johannes (1995) provide a summary of survey, monitoring, and collection methods. New (1998) provides a broad overview on survey design for invertebrates of conservation interest.

### Survey Design

The target species of conservation interest in Montana (Table 1) can be readily detected through labor-intensive hand searching. Hand searching involves picking through litter, shallow soil, and turning over rocks and fallen logs looking for attached animals. The length of time spent searching is recorded to provide a relative measure of search effort and rate of encounter (relative abundance) of the target species. In some cases it may be desirable to do searches at random locations along transects for quantitative comparisons by habitat or site. Search areas of some size (e.g. 1x1 m) are examined along transects for a set time, and the number of individuals found in each search plot recorded.

Habitat data associated with each transect and/or plot can include simple things such as estimates of overhead canopy cover and species composition, the same for ground cover, soil type or source rock type, slope and exposure; mean particle size of stones, talus, or boulders should be documented at sites in rocky terrain. For very small snails, soil samples are extracted from plots and screened on the spot using fine sieves, or placed in bags for later screening either through sieves or under Berlese funnels; these soil/litter extraction methods are not especially useful for the species discussed in this report. Ambient temperature, cloud cover, comments on precipitation (current, recent, and duration) and related weather data should be recorded, as weather is a significant factor in determining the degree of success of surveys. For recent examples of how sampling can be tied to habitat analyses of a terrestrial mollusk fauna, see Kralka (1986) and Ports (1996). A broader perspective for quantitative descriptions of mollusk populations and habitats is presented in Bishop (1977).

Use of cover boards provides an alternative to hand searching, and is also useful in conjunction with hand searching. Cover boards provide quantitative assessments of relative abundance that are suitable for statistical analyses, and they also are useful for long-term sampling of rare species at specific locations when resources for field surveys are limited to only a few (or no) periods of hand searching. However, the cover board technique still needs assessment in talus sites to determine its usefulness in that kind of substrate.

At selected sites, either transects or grids of cardboard or masonite squares (transects of 30 x 30 cm masonite [Boag 1982]; selected sites with 56 x 71 cm cardboard [Gleich and Gilbert 1976]; grids of 75 x 75 cm cardboard [Strayer et al. 1986]) are placed apart at regular distances, often in a variety of

habitats or microhabitats in comparative studies. Each cover board represents a sample plot that can be checked as frequently or infrequently as resources (money and personnel) allow. The ground where boards are placed can first be wetted to elevate humidity beneath the boards (useful for revisits of only a few days apart), but for long-term sampling with few visits it is probably preferable to place boards early in the field season (spring, once ground is snow-free) and retrieve them in mid to late fall before snow again covers the ground (or left in place over winter and revisited the following spring). Multiple visits to check snails and slugs under the boards can be made during a field season; visits should be made to all transects or grids at regular sampling periods (e.g., monthly, bi-monthly, annually).

Vouchers of target species should be collected to confirm identification. Dead shells can be placed in film containers and protected with cotton. Live snails and slugs can be kept in containers with moist paper towels or wood until a determination can be made. If preservation is necessary, snails and slugs should be drowned in warm water, fixed in formalin, and stored in vials of 70% ethyl alcohol. All collected material should be accompanied by the date and location of collection.

**Timing of Surveys**

Terrestrial mollusks are most active when conditions are cool and wet. During warm and dry conditions, a site may be searched with few or no encounters, when under moist and cool conditions the same site may reveal an abundance of live animals. Of course, dead shells may be found regardless of the weather, but finding extant populations is a first priority, and finding slugs will require favorable conditions if hand collecting is conducted. All species may be active shortly after the ground becomes snow-free, when the ground is moist from snowmelt, and will remain active until snow covers the ground or hard freezes occur, except during periods of hot dry summer weather. For Montana, the field season extends from late March or early April through October in most years and at lower-elevation sites.

Some searching at night may be fruitful during drier periods, but this is yet to be determined for the species discussed in this report. Brunson (1956) speculated that the Mission Range Disc (*Discus brunsoni*) could be most active in talus at night, when moisture conditions are more favorable, and that might explain how it was overlooked for so many years at the same locality where the Carinate Mountainsnail (*Oreohelix elrodi*) was collected frequently. Talus-inhabiting species (all species, for that matter) could show heightened surface activity at night when humidity levels are probably elevated. This possibility is worth investigating, as it has implications for future survey protocols for terrestrial mollusk species of conservation concern in Montana.

**Literature Cited**

Bishop, M. J. 1977. Approaches to the quantitative description of terrestrial mollusk populations and habitats. Malacologia 16:61-66.

Boag, D. A. 1982. Overcoming sampling bias in studies of terrestrial gastropods. Canadian Journal of Zoology 60:1289-1292.

Brunson, R. B. 1956. The mystery of *Discus brunsoni*. The Nautilus 70:16-21.

Frest, T. J., and E. J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern. Final Report to Interior Columbia Basin Ecosystem Management Project. Deixis Consultants, Seattle. 274 pp.

Gleich J. G., and F. F. Gilbert. 1976. A survey of terrestrial gastropods from central Maine. Canadian Journal of Zoology 54:620-627.

Kralka, R. A. 1986. Population characteristics of terrestrial gastropods in boreal forest habitats. American Midland Naturalist 115:156-164.

New, T. R. 1998. Invertebrate surveys for conservation. Oxford University Press. Oxford, UK. 240 pp.

Ports, M. A. 1996. Habitat affinities and distributions of land gastropods from the Ruby Mountains and East Humboldt Range of northeastern Nevada. The Veliger 39:335-341.

Strayer, D., D. H. Pletscher, S. P. Hamburg, and S. C. Nodvin. 1986. The effects of forest disturbance on land gastropod communities in northern New England. Canadian Journal of Zoology 64:2094-2098.

# APPENDIX D. KEY TO THE GENERA OF TERRESTRIAL MOLLUSKS OF MONTANA

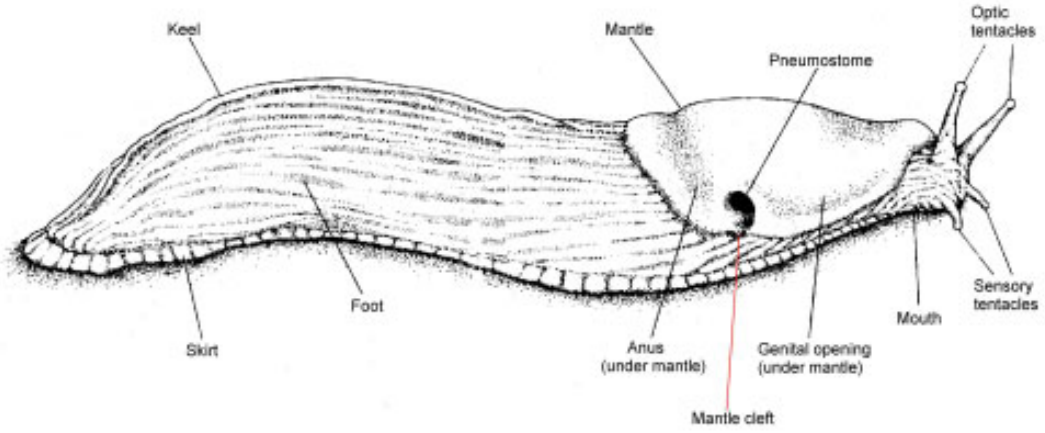



Figure D.1 Anatomy of a Slug

The following dichotomous key to the genera of terrestrial mollusks (slugs and snails) in Montana is based on one developed and revised in 1967 by Dr. Royal Bruce Brunson, Lee Fairbanks, and Richard Russell. Excluded in this current version are all aquatic taxa. The key is presented here to land managers and biologists as an aid in identifying slugs and snails that may be of special conservation concern. In the case of slugs, all genera of special interest are monotypic (represented by a single species) in Montana.

## All Terrestrial Mollusks

1a. Shell absent externally or greatly reduced (go to slug key).
1b. Shell present, covering the entire animal (go to snail key).

## Slugs

1a. Mantle elevated as a hump, shell may be partly exposed in a dorsal slit in the mantle—*Hemphillia*
1b. Mantle not elevated, shell never exposed—2

2a. Length of mantle greater than two-thirds the length of the animal—*Magnipelta*
2b. Length of mantle less than two-thirds the length of the animal—3

3a. Sole tripartite (having 2 longitudinal furrows), back generally keeled near posterior end, pneumostome (breathing pore) in posterior half of mantle margin—4
3b. Sole undivided, back not keeled, pneumostome in anterior half of the mantle margin—7

4a. Posterior margin of mantle notched, pneumostome above or in front (anterior) of mantle cleft—5
4b. Posterior margin of mantle unbroken, pneumostome behind (posterior) mantle cleft—6

5a. Color black or dark brown—*Zacoleus*
5b. Base color bluish-gray, dark lateral lines on mantle—*Udosarx*

6a. Greater than 50 mm in length, base color tan, variously spotted with black—*Limax*
6b. Less than 50 mm in length, color brown or black—*Deroceras*

7a. Base color orange, color of sole much the same as upper (dorsal) surface, anterior third of mantle free (unattached to dorsum), caudal pit at tip of tail indistinct, length up to 70 mm—*Prophysaon*
7b. Base color gray or orange to brown, sole generally much paler than upper (dorsal) surface, caudal pit at tip of tail distinct, length varies, up to 150 mm—*Arion*

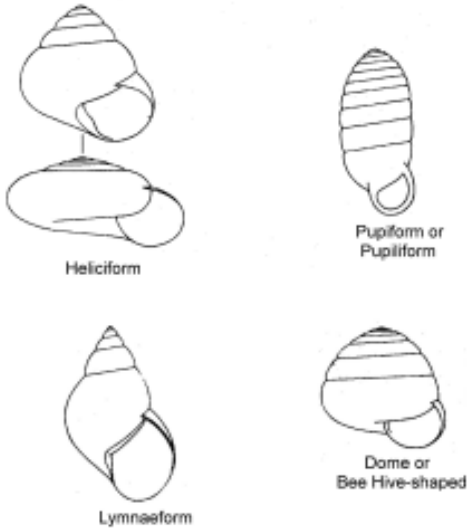



Figure D.2 Some shell shapes.

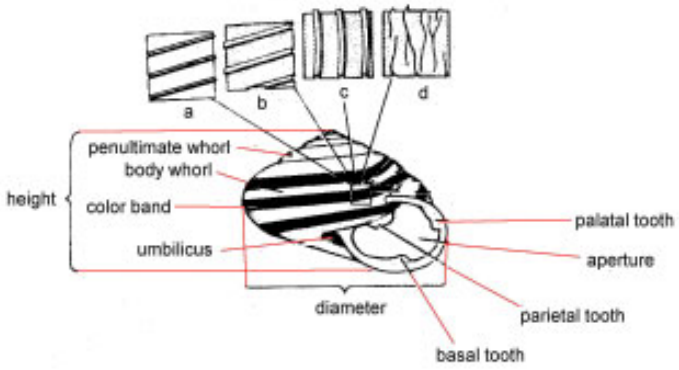



Figure D.3 Shell terminology. (a): striate (indented spiral lines, (b): lirae (raised spiral lines), (c): ribs (raised transverse lines), (d): wrinkles.

## Snails

1a. Shell lymnaeform (elongated coiled spire that is sharply pointed)—2
1b. Shell not lymnaeform—4

2a. Body whorl greatly enlarged, spire relatively short; shell generally thin and transparent—*Oxyloma*
2b. Body whorl not greatly enlarged or only slightly enlarged; length of spire at least a third the length of the shell—3

3a. Aperture (opening of shell) round; shell yellowish, clear; shell surface smooth or with nothing more than fine striae—*Succinea*
3b. Aperture oval; shell often chalky; surface with very fine file-like markings—*Catinella*

4a. Shell heliciform (flattened coil, wider than tall)—5
4b. Shell pupiform (elongated coiled spire, taller than wide, with blunt or rounded apex)—23

5a. Adult shell with reflected lip at aperture—6
5b. Adult shell without reflected lip—8

6a. Aperture with teeth—*Triodopsis* (*Cryptomastix*)
6b. Aperture without teeth—7

7a. Size 2-3 mm—*Vallonia*
7b. Size to 20 mm—*Allogona*

8a. Shell thin and transparent, generally smooth, less than 10 mm in diameter—9
8b. Shell opaque or with a color pattern; surface generally with ridges or striae; size varies—17

9a. Body whorl greatly enlarged, consisting of three quarters of the shell—*Vitrina*
9b. Body whorl not greatly enlarged or only slightly enlarged—10

10a. Widely umbilicated, width of umbilicus (central depression on the undersurface penetrating into the layered coils) one third or more the width of the shell—11
10b. Narrowly umbilicated—12

11a. Shell less than 2 mm in diameter; 3.0-3.5 whorls—*Striatura*
11b. Shell 2.5 mm in diameter; 4.0-5.0 whorls—*Hawaiia*

12a. Whorls about 5, tightly coiled—13
12b. Whorls not tightly coiled—15

13a. Shell nearly as high as broad, beehive-shaped—*Euconulus*
13b. Height of shell little more than half of the diameter—14

14a. Umbilicus closed; less than 5 whorls, spire somewhat elevated—*Pristiloma*
14b. Umbilicus open; more than 5 whorls; spire flat—*Microphysula*

15a. Shell height less than half of the diameter; more than 5 whorls—*Oxychilus*
15b. Shell height greater than half of the diameter; less than 5 whorls—16

16a. Whorls increasing in size, the body whorl being quite enlarged; shell clear and shiny—*Retinella*
16b. Whorls much the same size; shell amber or horn-colored, cloudy—*Zonitoides*

17a. Composition of shell chalky, often with a color pattern (banding) or various ridges—*Oreohelix*
17b. Composition of shell chitinous or horny; color yellow or brown—18

18a. Diameter of shell greater than 15 mm; whorls 5-6—19
18b. Diameter of shell less than 12 mm; whorls 4-8—20

19a. Height of shell greater than half the diameter; size 17-25 mm—*Anguispira*
19b. Height of shell less than half the diameter; size 22-32 mm—*Haplotrema*

20a. Diameter of shell less than 2.5 mm—*Punctum*
20b. Diameter of shell 5-12 mm—21

21a. Apical 1.5 whorls with spiral striations—*Radiodiscus*
21b. Apical whorls bare or with radial growth lines—22

22a. Whorls 7-8, tightly coiled; aperture with teeth—*Polygyrella*
22b. Whorls 4-5, not tightly coiled; aperture without teeth—*Discus*

23a. Aperture without teeth—24
23b. Aperture with teeth—25

24a. Aperture round; shell 3 mm in height—*Columella*
24b. Aperture ovate; shell 5 mm in height—*Cionella*

25a. Six whorls; 2-3 teeth in aperture—*Pupilla*
25b. Seven whorls; more than 3 teeth in aperture—26

26a. Three teeth in the aperture on parietal (outer) wall; whorls about the same width—*Vertigo*
26b. Four teeth in the aperture on parietal wall; body whorl widest of the whorls—*Gastrocopta*